EP 30 1931

Engineering and Mining Journal

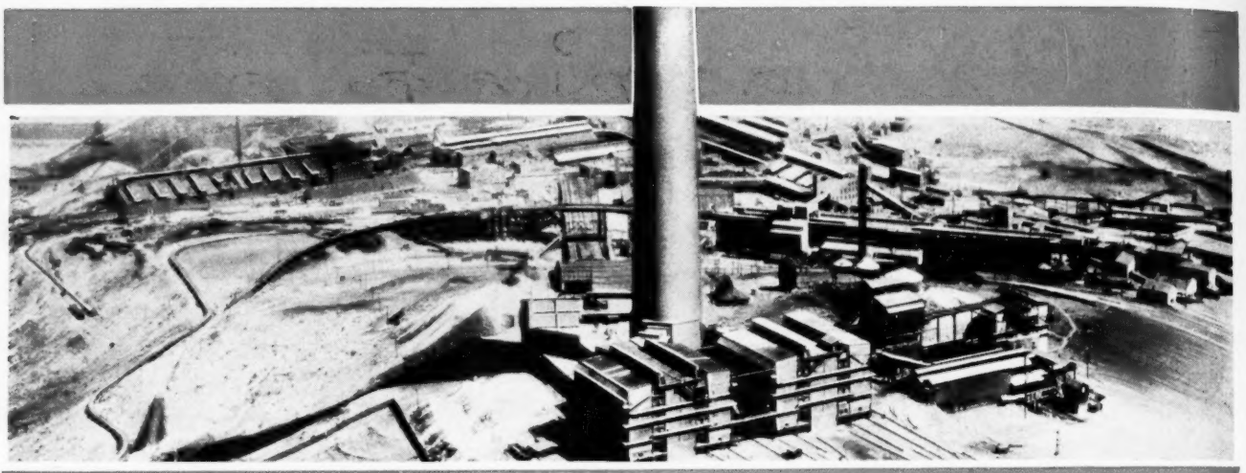
The Underground Mill and Flotation Plant of the Empire Zinc Company At Gilman, Colorado

... In This Issue

September 28, 1931

McGraw-Hill Publishing Company, Inc.

Price Twenty-five Cents Per Copy



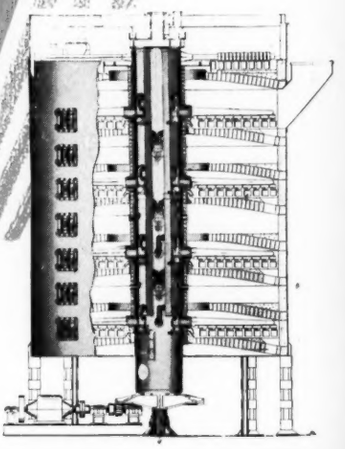
PENETRATION
and WEDGE ROASTING FURNACES

So general is the use of the Wedge Roaster and so thorough is its penetration into the metallurgical field, that engineers and smelter men commonly speak of their roaster units as "The Wedges." To these men, most of them old timers in the game of mining and smelting, "Wedge" is the one word synonymous with Roaster; it can mean nothing else.

The Wedge Furnace has penetrated the field because, from the beginning, it has been a sturdy machine with many years of service built into it, and because it has been modified in each case to the operator's particular roasting problem and his local conditions.

Write us fully regarding your drying, roasting or calcining problem.

BETHLEHEM FOUNDRY & MACHINE CO.
Wedge Furnace Dept.
BETHLEHEM, PENNA.



For Roasting,
Drying,
Calcining

BETHLEHEM-BUILT

Associate Editors
E. H. ROBIE, A. H. HUBBELL
Assistant Editors
W. N. P. REED, H. D. KEISER
S. D. STRAUSS, B. H. STROM
Market Editor
H. H. WANDERS

Engineering and Mining Journal

A. W. ALLEN, *Editor*

San Francisco
GEORGE J. YOUNG
Associate Editor

Tucson, Ariz.
JOHN B. HUTTL
Assistant Editor

Publishing Director: H. W. CLARKE
New York

Contents for September 28, 1931

Contents Copyright 1931 by McGraw-Hill Publishing Company, Inc.

VOLUME 132 . . . NUMBER 6

Editorials 241

Uncontrolled Individualism and Its Aftermath . . . Safety Council Attacks Fundamental Problems . . . Setting Light to Work in Industry . . . Comparing Per-Ton Grinding Costs . . . Why Not More Metallic Publicity for the Metals? . . . Mechanization Trend Will Still Be Forward

Sintering Minnesota Iron Ore ..... *A. H. Hubbell* 244

Rope-Drum Chart ..... *Sydney C. Mifflen* 248

The Petersen Tower Process ..... *Dr. Hans Schütt* 249

Empire Zinc Operations at Gilman ..... *W. O. Borcherdt* 251

Smelting Rich Lead Products ..... *John B. Huttl* 262

Cornish China Clay ..... *Ernest H. Davison* 264

Barytes Mine Produces Gravel ..... *H. D. Keiser* 266

Comment, Criticism, Personals 268

Industrial Progress 269

News of the Industry 272

Market and Financial News 279

Professional Directory 22

Advertising Index 24

McGraw-Hill Publishing Company, Inc.
Tenth Avenue at 36th Street
New York, U. S. A.
Cable address: "Machinist, N. Y."

JAMES H. McGRAW, Chairman of the Board
MALCOLM MUIR, President
JAMES H. McGRAW, Jr., Vice-Pres. and Treas.
MASON BRITTON, Vice-President
EDGAR KOBAK, Vice-President
HAROLD W. McGRAW, Vice-President
H. C. PARMELEE, Editorial Director
C. H. THOMPSON, Secretary

Published semi-monthly. Price in the United States and possessions, 25 cents (U. S. Currency) per copy; $4 per year. In all other countries, $20 per year—24 issues. Entered as second-class matter, June 20, 1879, at the Post Office, New York, N. Y., under the Act of March 3, 1879. Printed in U. S. A.

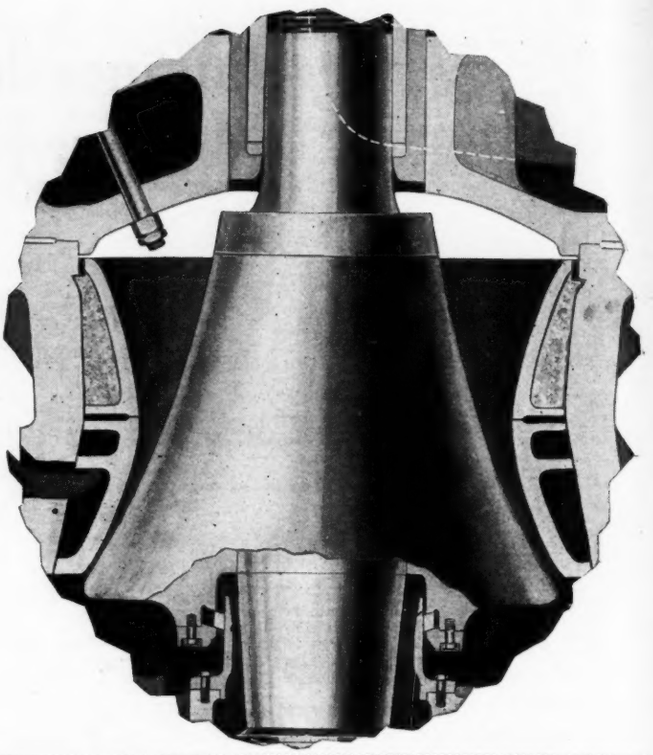
Member A.B.P. *Member A.B.C.*

6,760 COPIES PRINTED THIS ISSUE

NEW YORK District Office, 285 Madison Ave.
WASHINGTON, National Press Building
CHICAGO, 520 N. Michigan Ave.
PHILADELPHIA, 1600 Arch Street
CLEVELAND, 501 Guardian Building
ST. LOUIS, 1556 Bell Telephone Building
SAN FRANCISCO, 883 Mission Street
BOSTON, 1427 Statler Bldg.
GREENVILLE, S. C., 1301 Woodside Bldg.
DETROIT, 2-257 General Motors Bldg.
LOS ANGELES, 632 Chamber of Commerce Bldg.
ENGLAND, Aldwych House, Aldwych, London, W. C. 2

TZ REDUCTION CRUSHER

years ahead in crusher Design!



Consider these 7 points that set a new standard in the field today—

1. A breaker of greater capacity at smaller than usual setting.
2. Makes less oversize than others.
3. Has larger receiving opening and greater ratio of reduction.
4. Has no choking point.
5. Has adjustment range of fifty percent.
6. Adjustable during operation.
7. Made in six sizes to meet all requirements.

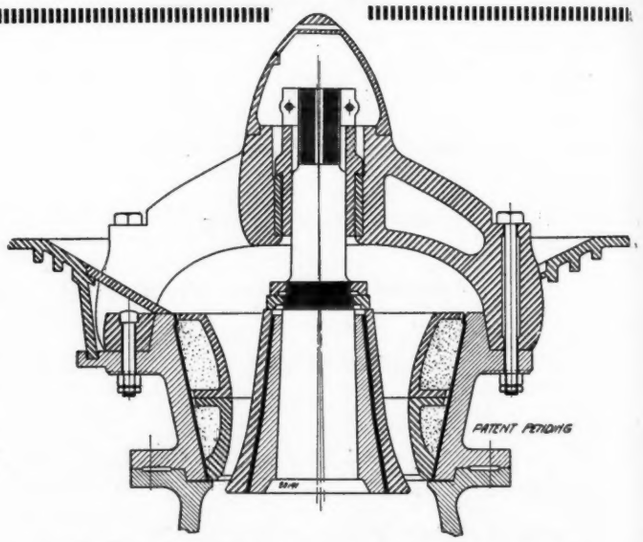
Bell heads **MUST** be used *with* CURVED CONCAVES

CAPACITY DOUBLED

with Traylor original non-chokable head and concaves

The capacity of your old Gates, Austin, McCully or any other Gyratory Type Crusher regardless of age can be increased 100% at closer settings; choking is eliminated, setting may be half the present minimum; crushing surfaces of head and concaves wear uniformly; product is more uniform with less percentage of wasteful fines.

Bulletin 110 tells the whole story



A No. 6 K Gates Gyratory Crusher Fitted with the New Bell Head and Concaves

TRAYLOR ENGINEERING & MANUFACTURING CO.
ALLENTOWN, PENNSYLVANIA, U.S.A.

New York City 2513 Empire State Bldg. | Chicago 1414 Fisher Bldg. | Los Angeles 908-909 Chester Williams Bldg. | Seattle 815 Alaska Bldg. | Salt Lake City 101 W. 2nd So. St.

Timmins, Ontario, Canada—Moore Block

EXPORT DEPARTMENT—104 PEARL STREET, NEW YORK CITY
Foreign Sales Agencies: London, Rangoon, Sydney, Melbourne, Johannesburg, Lima, Sao Paulo, Rio de Janeiro, Buenos Aires, Santiago, Valparaiso, Antofagasta, Iquique, Oruro

European Works—Usines Carels Freres, Ghent, Belgium

Engineering and Mining Journal

September 28, 1931 A. W. ALLEN, *Editor* Vol. 132—No. 6

Uncontrolled Individualism and Its Aftermath

CHAMPIONS of price paring to the uttermost limit, and of a bitter and ruthless competition in which personal unselfishness or concern for national welfare is conspicuous by its absence, invariably overlook the domestic problems of an industry of which they have no intimate knowledge. The author of "The Masquerade Of Monopoly," recently published, deplores the fact that the domestic producers of copper refuse to sell, at a price at or below the cost of production, more metal than a consumer requires for immediate needs. He sees in this refusal a breakdown in the "system of economic liberty in domestic commerce."

Retrogressive propaganda surely never reached so low a level as when it counseled a course leading to bankruptcy. Dr. F. A. Fetter, the author of this latest apologia for the Sherman Act, quotes the essential cost of producing copper, and he argues that this figure must form the basis for selling price, perhaps after a minimum allowance for interest to the owners of copper corporations. Recent history has shown that unrestricted production and vicious competition certainly cause a lowering of prices, but it also shows that the world at large is reduced to such a condition of widespread poverty that it cannot buy in normal quantity at any price. Let this aspect of the matter pass, however. The point that economists and other students of figures fail to realize is that the mining industry, in the interest of humanitarianism and local standards of living, must be directed on something higher than a purely business basis.

Mines are not discovered and operated in the centers of cities or industrial areas, where social, recreational, educational, medical, and religious advantages are available, supported by the community at large or by the state. The mining company must usually provide these facilities at its own expense, paying high state taxes withal; and such extraordinary costs must be met from the proceeds of the sale of its products. It can skimp its legal responsibilities, although the facts indicate that these have been met to the full by all reputable corporations. The moral responsibility goes far deeper, however—deep into the ground, as a matter of fact, where men work away from normal air conditions and sunlight.

To compensate for the disadvantages and discomforts and hazards incidental to underground operations has been the subject of earnest endeavor on the part of officials and operators in recent years, following major attention to complex technical problems the solution of which was imperatively necessary to cope with decreasing metal content per ton of ore. Under profitable metal-price conditions a serious effort was made to combat sickness and disease, particularly silicosis and tuberculosis, by extraordinary measures, involving heavy monetary outlay. One progressive executive, after an elaborate study of the effect of light on health, went to the expense of providing an ultra-violet solarium, under expert direction, for the benefit of miners and their dependents.

The emulation and repetition of inspiring and courageous efforts of this kind, aiming to mitigate the effect of working conditions to which economists apparently never give a thought, have been brought to a halt by the need to pare expenses in conformity to a disastrous price level that barely covers, or fails to cover, the cost of production. That fertile field for humanitarian effort—the conditioning of air in mines and the allaying of the dust that causes tuberculosis—has become a subject on which further consideration must be postponed, until a recovery in income provides the wherewithal to carry forward the work. Meanwhile a school of economists deplores any effort to restrict production in line with demand, lest such adjustment automatically raise commodity prices to a level permitting industrial companies to meet humanitarian responsibilities toward their workers, as well as financial obligations to their stockholders. The result is stagnation and a deadlock. The machinery for raising the physical, mental, and intellectual standards of miners is coordinated and available. Mining companies, especially the larger units that are criticized by Doctor Fetter in the book to which reference has been made, have made a praiseworthy contribution to national advance in this respect; but further progress is now in danger of being crippled by the effect of thoughtless propaganda which insists that the bare cost of producing a metal, like the cost of producing wheat or a manufactured article, must govern the selling price, without consideration of other and far more important factors.

Safety Council Attacks Fundamental Problems

THE tentative program for the Annual Safety Congress to be held in Chicago, October 12–16, indicates a growing appreciation of the influence of many factors that have been given scant attention by safety executives in the past. The relation between the hazard of accident and the state of health of the employee is one of these. A second is the question of discipline and its influence on a safety-first plan of campaign. How far should enforcement be pursued in a phase of the work in which executive and administrative example is not applicable? A third subject for debate raises the question as to what constitutes a lost-time accident. Does it mean absence from

work for a day or for a few days? Standardization will help to make practicable a comparison of safety-first achievements.

Mines and milling plants are being mechanized to maximum degree. The effect of this influx of machinery must be studied, and a mechanical safety program outlined. The advantage of physical examination before and during employment is another moot question to be discussed at Chicago. Safety engineers may find the cause of many accidents in a neglect to determine the initial physical condition of the employee, or in a neglect to maintain the human machine at a high physical standard. Finally, the congress will discuss the hazard of falls of rock in mines, and a factor that has an unrealized influence on accidents—illumination. The best and safest methods of lighting in metal mines will be a topic for a final discussion, and no other subject on the agenda is likely to attract more attention.

The present is an opportune time to formulate definite plans for the future. Attendance at the Chicago convention in October will prove a profitable investment. Development of valuable data and of inspiration should result, both of which are needed before a good safety-first plan can be devised and put into practice.

Setting Light to Work in Industry

OF THE electron tube the prophecy has been made that eventually it will control, regulate, or affect in some important respect everything the average man sees, hears, or buys. Sweeping as this assertion is, it will be respectfully received by anyone who understands the nature of the device and has had an opportunity to scan the list of applications thus far made of it. Mr. O. H. Caldwell has called the tube an electrical lever, likening its invention to Archimedes' discovery of the power of the lever, and has styled it a universal tool for industry. Although its performance, in both its thermionic and photo-electric forms, seems to the layman often to involve magic instead of the working of a principle of physics, the engineer or executive in mining or other work, who would like to apply it somewhere if only he understood it, is assured that the road to such application is not as difficult as it seems. Standardization of photo-electric devices, in particular, has facilitated their application to the simpler types of problems. As Mr. W. R. King said before the American Institute of Electrical Engineers last January, the plant engineer no longer needs to begin at the bottom and learn all about photo-electric tubes and amplifying systems when he sees the possibility of applying light-sensitive devices to advantage.

Among the applications already made of the photo-electric cell at mines and metallurgical plants is its use to signal the hoist engineer as the skip approaches or leaves the dump; to indicate when the ore in storage bins has reached the proper level; to control the depth of bed on the pallets of a sintering machine; for controlling artificial lights in accordance with the intensity of natural daylight; as a smoke recorder; as an indicator to prevent the shaft station gate from being opened before the cage is at the landing; to open furnace doors from the cab of a traveling crane; and to speed the work of recording ingot temperatures with a thermocouple. In all these applications, the control desired is effected through the intercepting of a beam of light or through change in the intensity of the light falling on a surface. In other words, light—natural or artificial—is set to work. Thus, in every plant or outdoor place, the means for performing some task automatically or semi-automatically, in conjunction with a light-sensitive device, is at hand. So simple is the application of this form of electronic tube, once the opportunity for it is perceived, that the prospects for its widened adoption by the mining industry are most promising. Readers who are using it or who may be led to do so are invited to recount their experience.

Comparing Per-Ton Grinding Costs

TECHNICAL result with most metal-extraction processes is dependent on the fineness to which the ore is ground. But, in most instances, careful study must precede a decision outlining the precise mesh aperture at which results will be most profitable. In some instances the problem is complicated by the need to consider the possibility of re-treating the residue at some future date, the economic practicability of which may depend entirely on the extent to which the ore was ground in the first instance.

Theoretically, the finest grinding should expose the maximum amount of metal or mineral to the action of the solvent solution or the concentrating apparatus, and result in the highest possible extraction. These benefits of maximum exposure are sometimes more than counterbalanced by mechanical complications and unfavorable surface-tension influences. The ideal is the highest possible extraction at the lowest possible cost, and concessions are usually made in efficiency to effect an economy, and vice versa.

In making a decision as to the degree of grinding to be adopted, therefore, one of the most important factors is the cost of reduction—coarse, medium, fine. This may vary in different localities and with different ores, but these differences do not constitute a valid reason to account for the paucity of cost data available, which is badly needed for comparative purposes. Many company reports and technical articles give screen analyses of the ultimate residual product and the cost of reduction per ton. What is needed, however, is an index referring to some specific range of reduction with a given ore hardness.

A veteran metallurgist suggests that a much closer coordination of results at many plants would be possible if information were published giving the cost per ton or reducing ore from run-of-mine to minus-100 mesh. The mesh aperture chosen, is, of course, an arbitrary one; but it probably marks the degree to which the major tonnage of metallic ore is being reduced today. In some instances the entire tonnage is ground so that no 100-mesh oversize is treated; in others, only a part. Whatever the proportion, cost per ton reduced to pass a definite mesh dimension would provide information of great value for comparative purposes. Will metallurgists please voice their opinions of this proposal; and, if in agreement, cooperate to put it into effect?

Why Not More Metallic Publicity for the Metals?

DOWN South the throne of "King Cotton" has wobbled, even tottered, and various have been the endeavors to restore some semblance of stability to that doughty regent's regime. One innovation, an all-cotton writing paper sponsored by Governor Huey P. Long of Louisiana, and other prominent Southerners, has attracted attention. Besides its unquestioned durability, the paper has a smooth, attractive surface and a substantial body that make it suitable for business or personal correspondence purposes. These characteristics are largely attributable to a kaolin sizing; which information may lend some encouragement to a group of nonmetallic producers whose market has also experienced contraction. But more effective than as an additional outlet for cotton and kaolin, perhaps, will be the all-cotton paper as an aid in directly and indirectly focusing attention on cotton and the problems of the cotton industry.

Although the use of all-cotton letter paper may be new, the general employment of stationery materials for advertising and publicity purposes has been practiced in various forms to a limited extent. For instance, letters from the offices of a certain manufacturer of lead pencils invariably carry penciled signatures, and the letterheads of several companies that make metal products bear, in metallized embossing, faithful facsimiles of the wares of the respective companies. And, to carry the illustration further, reference may be made to the fact that at the year-end holidays this office is accustomed to receive from an ardent member of the copper industry an attractive greeting "card" that consists of an appropriate message etched on a thin copper plate.

Now that various metal powders—including those of nickel, copper, tin, cobalt, and silver—are available, in addition to other physical forms, such as sheets, leaf, paints, inks, and plating solutions, the extensive employment, *per se*, of the metals as advertising and publicity media would seem desirable and practicable. Aluminum has gained much attention and broader markets by such means. Similar methods of publicizing the other metals, their merits, and fields of application might well form the basis for original thinking on the part of producers and affiliated interests.

Mechanization Trend Will Still Be Forward

IN TIMES like these, when many individuals, in quest of a scapegoat for present ills, are too ready to blame mechanization of industry for the prevailing unemployment, and to suggest, as a remedy, a retrogression toward a lower efficiency in production, one should reaffirm his faith in the thesis that those qualities in man that have caused him to press forward and upward to his present level of intelligence will not, indeed cannot, suddenly fail. The urge of the inventor to invent, of the person who inwardly is an engineer to perform a given task in the easiest, simplest way, of the artist to strive for the perfect expression of beauty—this urge, inexplicable as it is, is akin to that which, in similarly unknowable manner, causes a species to adapt itself to its environment. The explanation of these impulses lies hidden in the nature of things, which, despite much prying and guessing, thus far defies analysis. The impulse in each case persists, so that the inventor will keep on inventing and the engineer will continue to apply each new discovery. This being so, a retreat from the present mechanized state of industry is unthinkable, or, if it were forced, perhaps through some cataclysm destructive to society, the urge toward perfection, toward maximum efficiency, would immediately reassert itself and the climb upward would begin again.

Barring a cataclysm—and few are so pessimistic as to think society is really headed in that direction—the intelligent man will surely admit that mechanization, and all the word implies, is the natural permanent state for industry and society in the future. It has brought new problems and may bring others. It may eventually force a change in the social structure, as might be necessary if with the aid of the machine a small portion of mankind could produce everything that mankind needs. But to rail at mechanization because of the difficulties that accompany its advantages is foolish and futile.

The extent to which industry and all pursuits of society can be mechanized is indeterminable, because of one's ignorance of the limits of invention. Some go so far as to say that in the United States the process has almost reached completion, and that another decade will see little left to mechanize. This view appears unfounded, even if limited to this country. So far as many other nations are concerned, the ground is scarcely touched. The world-wide field still offers many opportunities, even in the limited light of present knowledge. What possibilities the future has, only time can reveal.

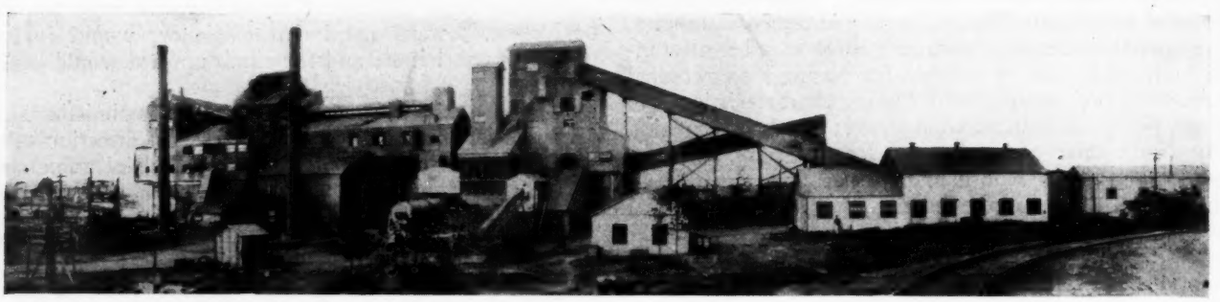
■ ■

AND SUCH A NEIGHBORHOOD, TOO!

Copyright, 1931, New York Tribune Inc.

Sintering Minnesota Iron Ore at the Evergreen Plant

A. H. Hubbell
Associate Editor



A near-by view of Evergreen sintering plant. The tubular dryer added for drying the coke breeze may be seen in the left center

Technical details incidental to the design and operation of the largest sintering machine in the world, by which a satisfactory low operating cost is secured. A new product, known as "sinter-dried ore," has proved to be an excellent furnace-charge material.

THE success achieved by the Evergreen Mining Company, of Crosby, Minn., in sintering certain limonitic ores of the Cuyuna Range is well known. Detailed descriptions of the work done by the Minnesota Sintering Company, Evergreen's subsidiary, were given before the Lake Superior Mining Institute and the A.I.M.E. by Perry G. Harrison,[1] general manager. Since these papers appeared, however, certain changes in procedure justify a further description. If, in the course of presenting it, some facts already published are repeated, the reader will appreciate that this is for the benefit of those who have not seen Mr. Harrison's papers.

Before considering the work of sintering, a brief sketch of the Evergreen operation as a whole will be given. The company is working five "forties" at Crosby, including three of its own and, in addition, the so-called Wearne "forty," belonging to the Inland Steel Company, and the Portsmouth tract, now under lease to Hanna interests. What was once three pits is now one continuous excavation, about ¾ of a mile long and 900 ft. wide, with approximately 6 miles of track. To accommodate its operations to prevailing economic conditions the company has adopted a half-time schedule, calling for running every other month, 24 hr. a day in the sintering plant and two 10-hr. shifts daily in the pit during the period of open navigation on the Great Lakes.

The ores of the Evergreen pit, in general limonites, vary widely in composition within short distances as they lie exposed by operations to date. This necessitates careful selection in mining, to permit proper grading, thereby to keep the crude ore supplied for sintering within the desired limits of analysis. This condition in turn necessitates mobility of shovel operation. The pit equipment consists of one Model 37 Marion steam shovel, with a 1¾-yd. dipper, for handling ore, and a Model 450 Marion electric shovel, convertible to crane or dragline as desired. The latter is used as an auxiliary in an emergency, and for loading coke and similar purposes. It has a 1¼-yd. dipper, 1-yd. drag bucket, and a 1-yd. clamshell. To secure the desired mobility, a special underslung car is provided for conveying either shovel from point to point. The Model 37 shovel, mounted for transport, is shown herewith. In average ground it can dig 2,000 tons in 10 hr.; the auxiliary shovel, 1,200 tons. Thus it may be seen that the pit work is conducted on a small scale, compared with usual Mesabi practice, but the task to be performed at this Cuyuna Range mine is different. To serve the shovels, for stripping and lean-ore removal, twelve 20-yd. air-operated side-dumping cars (nine K. & J. and three Western) are provided; also two American locomotives, of 50 tons' weight each, and two Baldwins, one 80 tons and the other 60 tons. All ore is loaded into standard railroad ore cars. An effort is made to hold track grades to 2 per cent on curves and 2.5 per cent on tangents.

Two-piece dipper teeth are used in digging. These are of manganese steel, as is likewise the dipper front. A set of teeth lasts ten to fourteen days, depending on the nature of the digging. The worn teeth are salvaged and built up by electric welding for further service. Little blasting is required. Overburden reaches a maximum of 75 ft.

The pit is shown in one of the accompanying illustrations. On the edge is seen the sintering plant, an "edifice" that has steadily grown in size in the last few years to keep pace with the increasing demand for Evergreen sinter, and which, when seen, either from the pit or across the muskeg, presents an imposing appearance.

The original sintering plant at Crosby, out of which the present one has grown, was erected in 1924 to treat the district's iron ores and manganiferous-iron ores running low in silica and high in moisture and having an objectionable proportion of fines. Experimental work ensued, resulting in slow growth. In 1928, a production of 115,546 tons of sinter was made on a 42 in. x 64 ft. Dwight-Lloyd machine. To reduce operating costs, the sintering machine was rebuilt to 72 in. x 76 ft., with which an output of 213,022 tons was made in 1929. In 1930, the sintering machine was lengthened to 125 ft., making the present machine 72 in. x 125 ft., the largest in the world. This increase in size also allowed for an increase in thickness of sinter bed, which now is operated 18 in. in depth. Production in 1930 was 275,266 tons of sinter. The

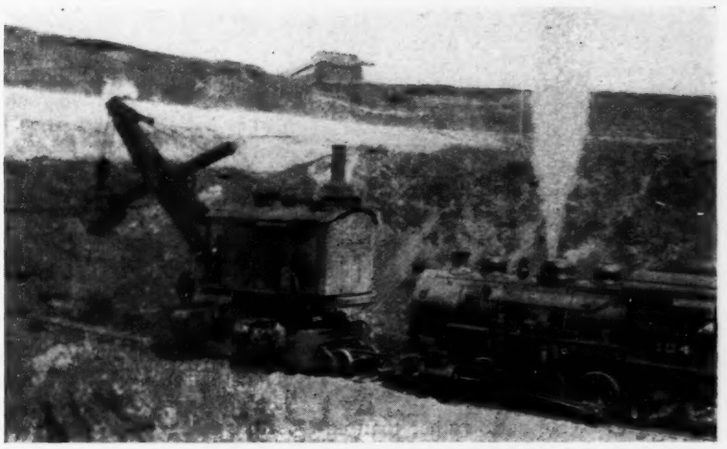
[1]Proceedings, L.S.M.I., Vol. 28, 1930. Also A.I.M.E., T. P. No. 284.

average sinter production for 24-hr. day compares as follows: 1928, 500 tons; 1929, 922 tons; 1930, 1,404 tons. Labor efficiency compares as follows: 1928, 11.86 tons sinter per man-shift; 1929, 16.77 tons; 1930, 19.30 tons. The depth of the charge on the bed has increased from year to year as follows: 1928, 11 in.; 1929, 15 in.; 1930, 18 in.

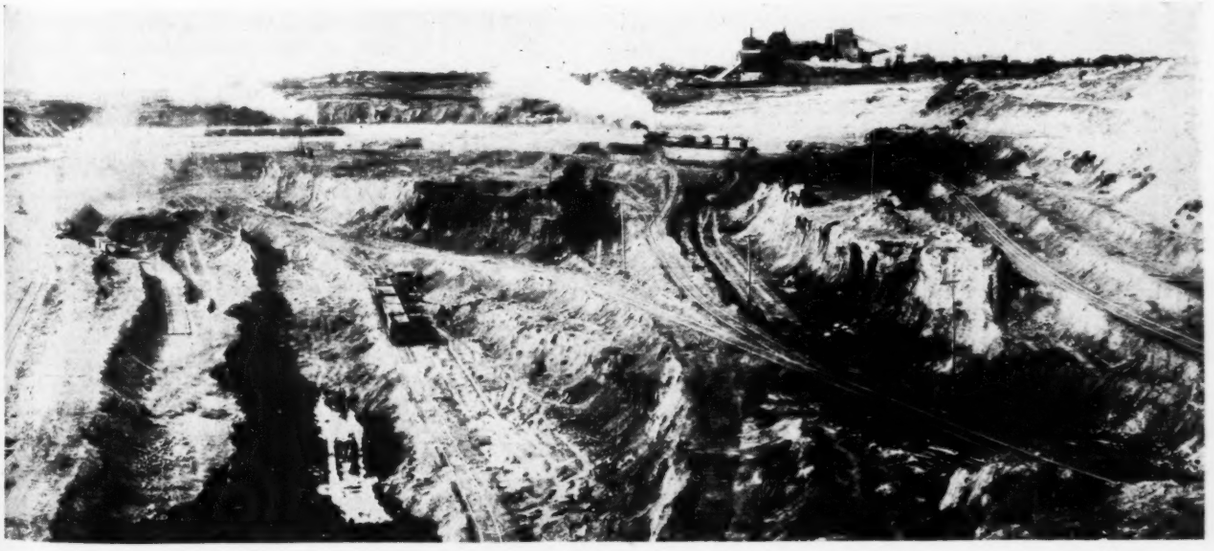
During previous years, the Evergreen Mining Company had been furnishing three products, sintered ore, screened oversize ore (from which the fines had been removed and sintered), and a crude crushed direct-shipping ore. Early in 1931, at a cost of approximately $4,800, changes were made in the ore-handling equipment, adding a new product to the company's line which nearly doubles the capacity of its plant for furnishing prepared ores. This new product is called "sinter-dried" ore. It is made by screening out the minus $\frac{3}{8}$-in. material and sintering it, while the oversize is discharged into the same railroad car with the hot sinter. The waste heat of the hot sinter is thus utilized to dry out some of the moisture in the oversize. The resulting sinter-dried ore is an excellent furnace product because of the structure, minimum of fines, and relatively low moisture. Just enough water spray is added in the car to quench any sinter lying against the sides of the car which would cause the paint to peel off the car. The new product is likely to make a place for itself, as it has proved satisfactory to the furnaces. Screen analysis taken at Lower Lake ports of both sinter and sinter-dried shows remarkably high-grade furnace products —that is, sinter, 88 per cent on $\frac{1}{8}$ mesh and only 0.6 per cent through 100 mesh; sinter-dried, 79 per cent plus $\frac{1}{8}$ mesh and only 3 per cent through 100 mesh.

To facilitate an understanding of Evergreen practice, the flow sheet given by Mr. Harrison in T. P. No. 284 (A.I.M.E., February, 1930) is herewith reproduced. The principal changes, since initiated, are as follows:

1. The substitution of Niagara screens for those formerly used.
2. For sinter-drying, the oversize from the screens is conveyed directly to the same railroad cars as the sinter.
3. The elimination of the bucket elevator and substitution of an incline conveyor between the 24-in. collector conveyor and the pugmill. This change reduced operating costs greatly by eliminating mechanical repairs and stopping a dust problem.
4. Change in length of sintering machine to 125 ft.
5. Increase in number of dust collectors to two, owing to increase in length of sintering machine making twelve windboxes for one dust collector and eight windboxes for the other.
6. Addition of a 45,000-cu.ft. fan.
7. Addition of another stack for the exhaust gases.
8. The removal of the Dorr-Davis washer from the sintering plant structure to a new building erected for washing purposes.
9. Change in ignition furnace equipment from that shown to a muffle-type oil-burning furnace of new design. There are two of these furnaces, one being a spare for use when the other is undergoing repairs.
10. The addition of a tubular dryer ahead of the Hardinge rod mill for reducing moisture in the coke breeze, when necessary. This dryer utilizes waste heat from the sintering machine.
11. The overflow from the Dorr classifier after the dust collectors is taken by launder to a Dorr thickener for clarifying the water before discharging through a launder into a stream for disposal. Behind the thickener is installed a sump box and 450-gal. pump for returning the clean water to the sintering plant for re-use, if the water supply is low, or for supplying the wash-



Ores that vary widely in grade within short distances in the Evergreen pit call for mobility of shovel operations. The Model 37 is here seen mounted on its car for transfer to another point.



Open pit of the Evergreen Mining Company, Crosby, Minn. It is approximately ¾ mi. long and 900 ft. wide. The sintering plant is on the far edge.

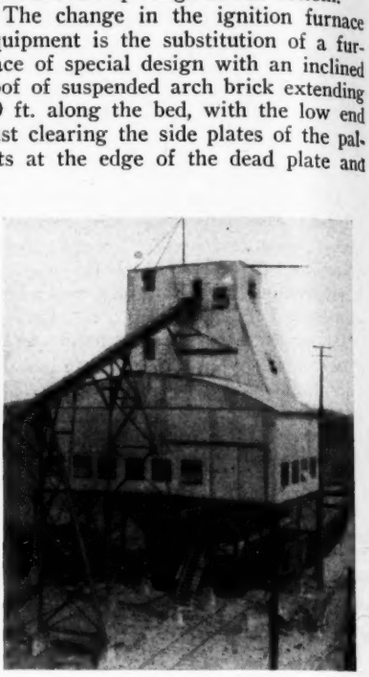
Another view of sintering plant, taken from the office. At left is seen the new washing plant and in front of it the concrete ore-storage bin.

ing plant with water for washing purposes when needed.

Changes number 5, 6, and 7 were made as duplicate parts rather than enlargements, for the purpose of insuring operation of part of the sintering machine should one unit fail.

The abrasive action of the sintered material coming through the grates, due to high vacuum from the fans, caused quick disintegration of the steel plates of the dust collectors ordinarily used. These were replaced with concrete collectors lined with special paving brick having key-shaped ends. They were laid up with the 4x4-in. ends inside, and the concrete was poured around the outer end, locking the keys into the concrete, so that the dust collectors have an 8-in. lining of paving brick. The baffle wall is also laid up of paving brick with arched openings at the bottom.

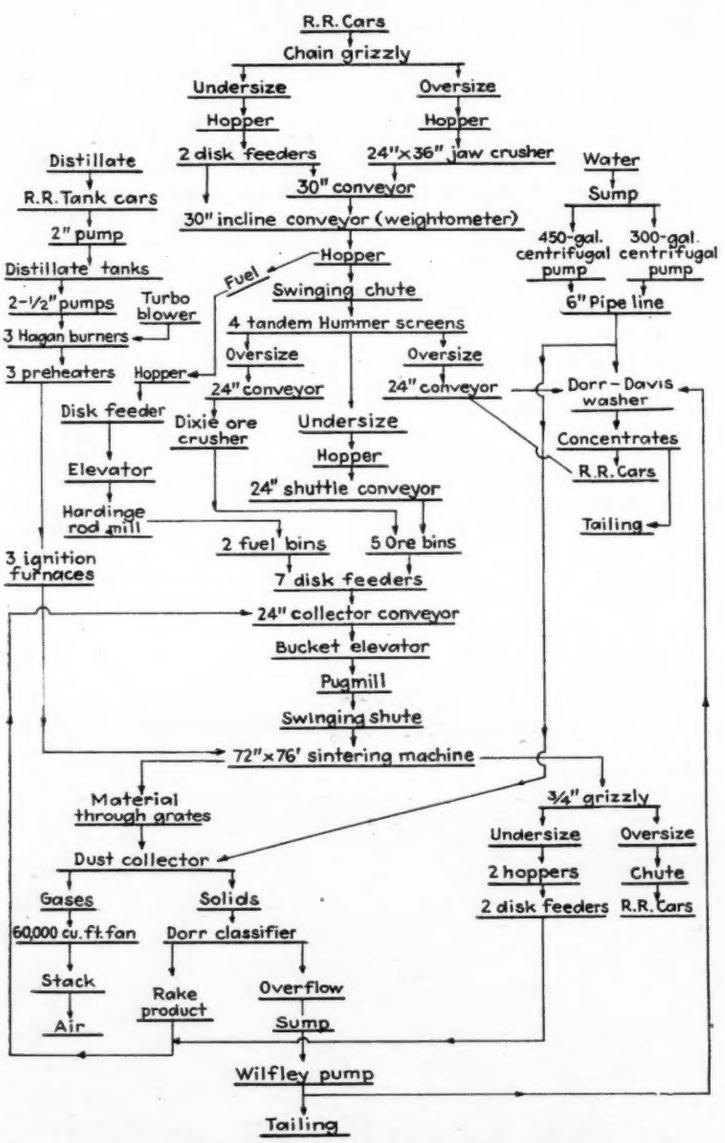
The change in the ignition furnace equipment is the substitution of a furnace of special design with an inclined roof of suspended arch brick extending 10 ft. along the bed, with the low end just clearing the side plates of the pallets at the edge of the dead plate and the high end 3½ ft. above the bed. Fuel used is 34-gravity gas oil fed to a Hagan No. 5 burner at 100-lb. pressure, where it is atomized with air at 1½-lb. pressure, the atomized mixture discharging into 4-in. heat-resisting pipes, passing twice through the highest portion of the furnace, then discharging through a gas-burner consisting of a 6-ft. length of 4-in. pipe closed on each end and nine ¾-in. holes drilled just below horizontal. The combustion occurs as a clear, blue gas flame directed down toward the bed by the inclined roof and pulled into the bed by the vacuum of the big fans. This gives an ignition surface, heated almost to incandescence for a distance of about 8 ft. along the bed with an oil consumption of about 1,200 gal. in 24 hours.



Experimental washing plant recently erected at the Evergreen. The unique construction is described in the text.

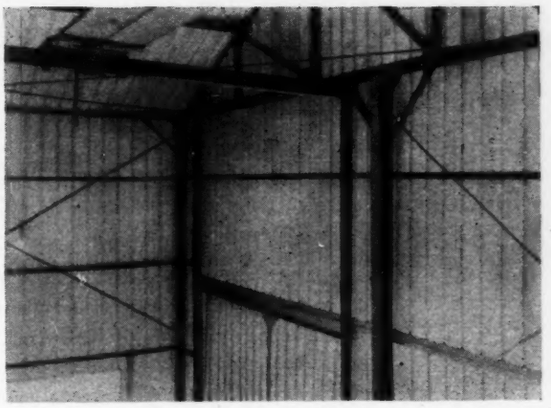
A new experimental washing plant has been erected during the past winter. This unit consists of a concrete ore-storage bin 36x36 ft. in plan and 30 ft. high. The bottom of the bin slopes at 50 deg. to a Chain-Belt Company pan conveyor 36 in. wide extending 30 ft. long, under the bin. This pan conveyor discharges on to a 30-in. incline conveyor to the top of the washing plant. The present equipment of this plant is a 48x96-in. double-deck Jigger vibrating screen and a Dorr-Davis washer with the trommel removed. What additional equipment may be added will be determined by further investigations.

Of great interest is the building itself, which is shown in the above illustration. The supporting beams and skele-



Flow sheet of Evergreen sintering plant prior to changes cited in accompanying text. Redrawn from T.P. No. 284, A.I.M.E.

ton framework were erected with a welded battle-deck steel floor. On this floor was mounted a standard Butler "Ready-Made" steel building, which comes completely fabricated with all sheets punched and marked, so that the only tools necessary for erection are a small wrench and screw driver. No skilled labor is required. This part of the structure is that covered by the round roof (see cut). To conform in appearance the upper projection for the screen installation is covered with sheets and windows of the same design. The standard building can be completely dismantled and erected on another site with full salvage value. It is manufactured by the Butler Manufacturing Company, of Minneapolis, Minn., and Kansas City, Mo. Other Butler buildings consist of a repair shop for locomotives and shovels, a pipe shop, blacksmith shop, motor and transformer house, pump house, and shelter house for dump crews. They are tight and heat easily in cold weather. They are said to cost less than any other type of construction the company could have built. They are shown in the cut on page 244.



Detail of "ready-made" steel construction, from interior of experimental washing plant

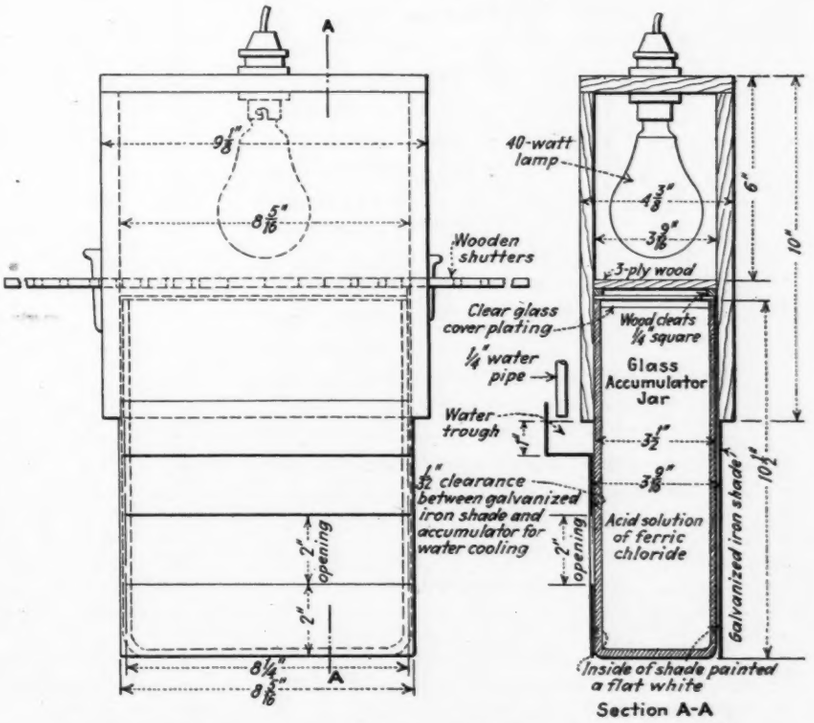
■ ■ ■

Drill Tempering With a Color-Matching Device

DRILL STEEL, of hollow-hexagon section as used on the Witwatersrand, requires uniform tempering to obtain the greatest volume of broken rock by the use of the smallest number of bits, writes A. Langley from Johannesburg. For the tempering of a bit at 77 deg. C., and quenching in water at 100 deg. F., and for the tempering of a shank somewhat below 77 deg. C., considerable difficulty would be experienced in controlling the quenching temperature within the narrow limits required. This control is accomplished by means of a color-matching device, which, in conjunction with air hardening, enables at least 95 per cent of the drills to be regularly hardened within the desirable limits, as follows: Impact face, between C40 and C50; collar, between C30 and C38. The hardness of the piston faces is C62, and of the chuck bushings, C55. Every shank is tested twice in the Rockwell machine before issue, and all defective shanks are returned to the shop for re-hardening. Shank and piston trouble is thereby almost completely avoided.

The apparatus consists of a glass jar, illuminated by a small electric lamp. The colored liquid is an acid solution consisting of 1 lb. of ferric chloride dissolved in one gallon of distilled water, to which ½ oz. of pure concentrated hydrochloric acid has been added. This solution is stable, and is not unduly affected by moderate heating. It has an invaluable optical property in that, as one dilutes it slightly, or as the amount of light shining through it is slightly increased, the orange or yellow content of the color is similarly increased, so that it gives a lifelike simulation of red-hot steel within the range of temperatures used. The different tints required for hardening shanks, water-quenched bits, or air-quenched bits are obtained by regulation of the shutters. Water must be added periodically to counteract evaporation.

The container is a rectangular three-quart accumulator glass jar, on which rests a box fitted with sliding shutters, containing a 40-watt electric light. The glass jar, painted white on the outside, is surrounded by a sheet-iron sleeve (also painted white internally), which has a small slot forming a window through which the color is seen. When the apparatus is used for drill bits, the front of the jar must be water-cooled, as shown. Otherwise, the constant proximity of the red-hot bits causes boiling of the solution.

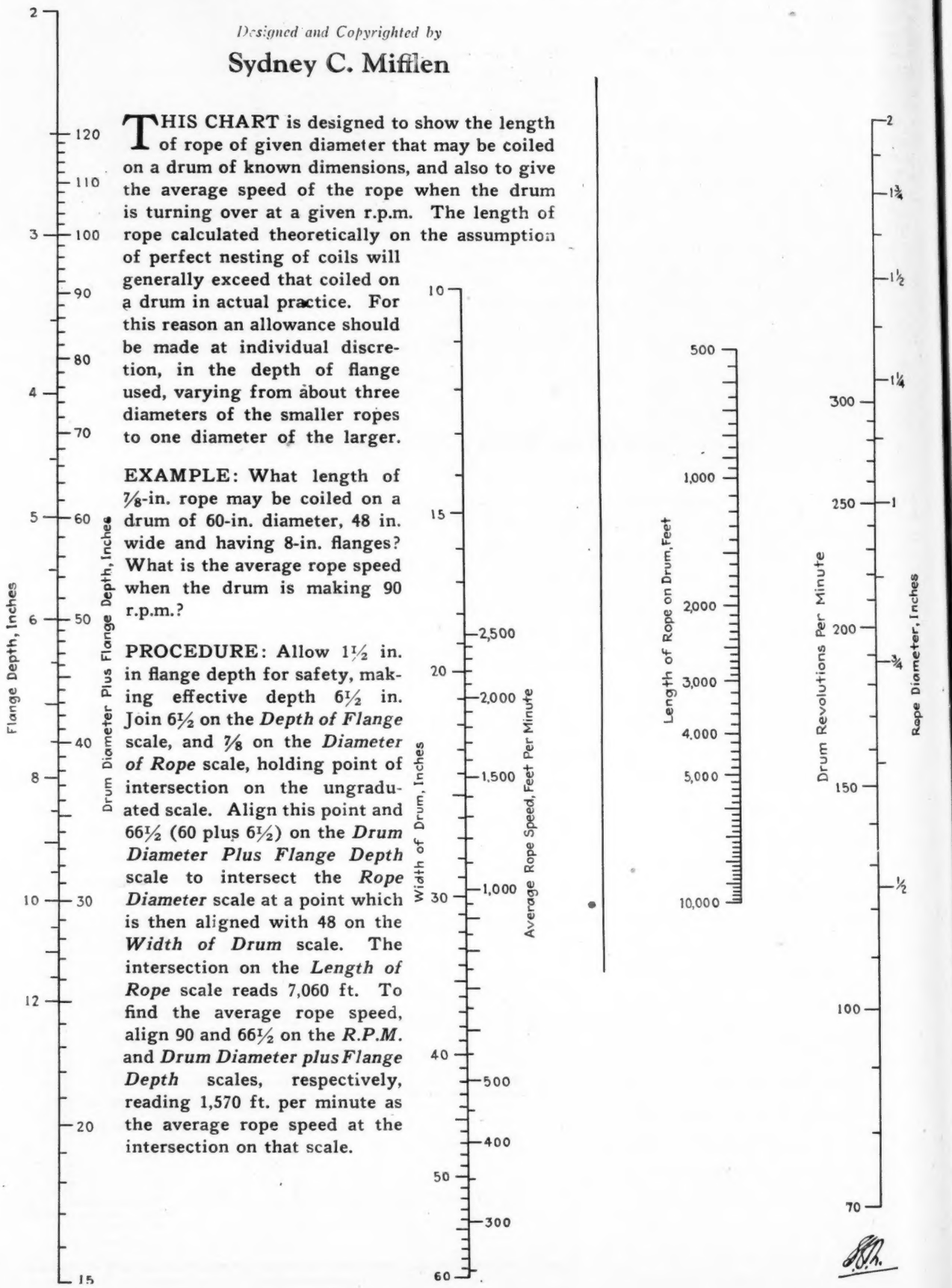


How to construct the apparatus that simulates the colors of hot steel at different temperatures

ROPE-DRUM CHART

Designed and Copyrighted by

Sydney C. Mifflen


Flange Depth, Inches
Drum Diameter Plus Flange Depth, Inches
Width of Drum, Inches
Average Rope Speed, Feet Per Minute
Length of Rope on Drum, Feet
Drum Revolutions Per Minute
Rope Diameter, Inches

THIS CHART is designed to show the length of rope of given diameter that may be coiled on a drum of known dimensions, and also to give the average speed of the rope when the drum is turning over at a given r.p.m. The length of rope calculated theoretically on the assumption of perfect nesting of coils will generally exceed that coiled on a drum in actual practice. For this reason an allowance should be made at individual discretion, in the depth of flange used, varying from about three diameters of the smaller ropes to one diameter of the larger.

EXAMPLE: What length of 7/8-in. rope may be coiled on a drum of 60-in. diameter, 48 in. wide and having 8-in. flanges? What is the average rope speed when the drum is making 90 r.p.m.?

PROCEDURE: Allow 1½ in. in flange depth for safety, making effective depth 6½ in. Join 6½ on the *Depth of Flange* scale, and 7/8 on the *Diameter of Rope* scale, holding point of intersection on the ungraduated scale. Align this point and 66½ (60 plus 6½) on the *Drum Diameter Plus Flange Depth* scale to intersect the *Rope Diameter* scale at a point which is then aligned with 48 on the *Width of Drum* scale. The intersection on the *Length of Rope* scale reads 7,060 ft. To find the average rope speed, align 90 and 66½ on the *R.P.M.* and *Drum Diameter plus Flange Depth* scales, respectively, reading 1,570 ft. per minute as the average rope speed at the intersection on that scale.

Sulphuric Acid by the Petersen Tower Process

Dr. Hans Schütt

TRENDS toward intensification of the nitrogen-oxide process for the manufacture of sulphuric acid have been in evidence ever since the year 1900. Sufficient advances have been made in this direction, by improvements in chamber design and by increased circulation of nitrogen oxide, to meet the growing competition from the contact process.

The most complete intensification obtained at present is gained through the use of tower systems (See Bruno Waeser: "Handbuch der Schwefelsäurefabrikation," Vol. 2, pp. 122 & 1,418). Use of towers for speeding up the the reactions, first suggested by Lunge, was introduced with the Lunge-Rohrmann plate columns, which, if washed at all, use dilute sulphuric acid, free from nitrous oxides. The performance of these towers did not, however, in any way fulfill the hopes entertained. Distinction of having first recognized the possibilities of nitrous vitriol for oxidation of sulphurous acid outside the Glover towers, as well as inside, must be given to Hugo Petersen, who in 1905 introduced the chamber regulator (German patent No. 208,028). A tower-shaped regulator, placed between the last chamber and the first Gay-Lussac tower, serves to oxidize the last traces of sulphur dioxide in the gas prior to its entry into to Gay-Lussac tower, by a spray of strong nitrous vitriol, maintained in continuous circulation.

• • • At the same time, Petersen also began to use nitrous vitriol for oxidation of gases of high sulphur-dioxide content, such as are found in the early stages of the process, after the Glover tower. This was done by placing a tower between the Glover and the first chamber, in circulation with the Gay-Lussac tower, a procedure later known as the "Inner Ring" (German patent No. 219,829). These measures furnished the necessary prerequisites for operation without chambers, with reaction towers only. Prior to this procedure, however, Petersen made practical experiments to manufacture sulphuric acid solely by the use of nitrous vitriol in shallow boxes filled with quartz, without employing either chambers or towers.

Independently of Petersen, Opl, from October, 1906, on, undertook experiments to replace the chambers with towers, and was able to erect the first plant at Bruschau. The towers, generally of rectangular cross-section, were filled with coke or with regular packing material, and were sprayed with nitrous vitriol. The circulatory system was so arranged that the first tower and the sixth, the second and the fifth, and the third and the fourth work in pairs, forming three independent rings. In the second ring, composed of towers two and five, the acid strength used is 62 deg. Bé. Compared with this, the central ring was operated at 55 to 57 deg. Bé., on account of the success achieved by Petersen with nitrous vitriol of this strength.

The Opl process is effected by the use of pyrite gas of constant strength. Large credit for development of this process, in regard to operating practice as well as to equipment, is due to Chemische Fabrik Curtius A.G., in Duisburg, which obtained a substantial increase in production per unit of space by the eight-tower system, and which also succeeded in treating cool, although uniform, pyrite gases. As the main reaction in the Opl process takes place toward the middle of the system, it is highly sensitive to fluctuations in draft and gas volume and to changes in the gas concentration. In a six-tower plant, the percentage of gas oxidized is as follows: In tower No. 1, about 20 per cent; in tower No. 2, 30 per cent; and in tower No. 3, about 50 per cent. In later years, Lurgi has used roller boxes in connection with Opl plants.

A distinct feature of the Petersen process is that oxidation of sulphurous acid is already effected in the first third of the plant by the aid of strong nitrous vitriol. (See article in *Metall und Erz*, 1927, No. 18, pp. 450-61, "Progress in the Manufacture of Sulphuric Acid With Special Reference to Metallurgical Waste Gases.") This condition and the intimate mixture between the gas and the nitrous vitriol, particularly in the reaction zone, permits great variations in the sulphur-dioxide content as well as in the volume of the gas. As the oxidation of the sulphurous acid is restricted to a comparatively small space, economical operation is possible with poor gases, containing as low as 1.5 per cent sulphur dioxide, by volume, such as are freqently produced in various metallurgical and chemical operations. The process is protected by patents granted and pending in Germany and most other countries.

• • • Twenty plants of this type built since 1923 consist exclusively of towers filled with regular packing material or with lumps of acid-resistant stone. With lump packing, the gas channels are so small that the gas, forcing its way through the interstices between the lumps, is brought into intimate and long-sustained contact with the liquid, and a reaction results that is more intense than with dispersers and similar mechanical devices. As a rule, the gas is first prepared by purification in a modern electric precipitation plant.

Any hot or cold gases containing sulphur dioxide may be used, regardless of fluctuations in content. An example of the use of normal pyrite gas is furnished by the plant of Dansk Svovelsyre & Superphosphat Fabrik (Danish Sulphuric Acid & Superphosphate factory), of Kalundborg, which was put into operation last year. This plant has a daily capacity of 180 metric tons of 60 deg. Bé. acid, with a nitric-acid consumption of 0.94 per cent (36 deg. Bé).

In conformity with common practice, circulation in this plant is effected by centrifugal pumps, the acid passing from the last tower to the one preceding, and so on. In addition to the amount transferred from tower to tower, a large quantity of acid is continually in circulation. By a simple and well-arranged system of ducts, this normal scheme may be modified at any time—an important operating feature in case of disturbances and fluctuations in the content of the gas. A large plant of this type may easily be operated by a single man per shift. The plant is able, with a slight increase in the consumption of nitric acid, to produce over 200 tons of acid per day. With a lower output the nitric-acid consumption drops correspondingly, as for instance to 0.8 per cent for 165 tons. A certain increase in nitric-acid consumption is generally advisable in order to raise the production of sulphuric acid, as the other operating expenses, such as power and labor, remain practically the same for the higher output. Power consumption at the Kalundborg plant is 17.5 kw.-hr. per ton of 60 deg. Bé. acid, including power for light and for operating blower and lift.

A similar plant, operated by Société Héllénique de Produits et Engrais Chimique, in Athens, has a daily capacity of 160 tons in the winter and 135 tons in the summer, the reduced capacity in the summer time being attributable to the unfavorable cooling-water conditions obtaining in Greece. An interesting feature at this plant is that the Gay-Lussac towers have no lead lining. In spite of this fact no escape of gas or leakage of liquid takes place.

The tower process has the advantage over the chamber process that it may be operated with the smallest units as well as on the largest scale. At present two very small installations, with a daily capacity of 4 and 1.2 tons, respectively, are being built in Persia and Afghanistan. The largest unit for treating pyrite gases, now under construction, is scheduled to produce 400 tons 60-deg. acid in 24 hours, and is one of the largest sulphuric acid plants in the world.

• • • Waste gases from metallurgical operations are utilized in many plants. The installation of Metallwerke Unterweser A.G., Friedrich-August-Hütte, in Oldenburg, Germany, produces up to 120 tons of acid from gases containing about 5 per cent sulphur dioxide, partly from hand-rabbled roasters and partly from mechanical furnaces used for preliminary roasting, and Dwight-Lloyd sintering machines. Gases of still lower sulphur-dioxide content are treated in the three installations of Compagnie Royale Asturienne des Mines. These gases are produced by sulphatizing roast of zinc blende and contain only about 3 per cent sulphur dioxide. The output is from 100 to 130 tons for two units, and 45 tons for the third. Utilization of the gas is rendered difficult by the fact that the roasting furnaces use direct firing with coal, so that a dilution with the gases of combustion takes place.

The plant of Société Générale Métallurgique de Hoboken treats a gas varying between 2 and 7 per cent sulphur dioxide. Up to 150 tons 60-deg. Bé. acid is produced daily, with a nitric-acid consumption of 1.5 per cent 36-deg. Bé. acid. A plant in central Germany, with a daily capacity of 20 tons, handles cold gases from a Dwight-Lloyd sintering apparatus with a fluctuating content of sulphur dioxide, and of varying volume. Treatment is also rendered difficult by heavy admixture of dust and water. Similar conditions obtain in the two Japanese plants at Shisakajima, where cold gases from Greenawalt sintering plants and from converters, with wide fluctuations in sulphur content and volume, are treated. Each of these plants has a daily capacity of over 100 tons 60-deg. acid.

Still wider fluctuations in concentration and volume are found in the plant at Gottesbelohnungshütte of the Mansfeld A.G. für Bergbau u. Hüttenbetribe, at Hettstedt, Germany. Here the gases have a temperature of less than 120 deg. F., the content of sulphur dioxide varies between zero and 9 per cent, and the gas volume between zero and 780,000 cu.ft. per hour. The operation is furthermore rendered difficult by the fact that, as a rule, the highest concentration of sulphur dioxide coincides with the largest gas volume. The gases originate in the converter plant, where a high-grade matte and blister copper are blown. A small denitrating tower, one tower 30 ft. in diameter and 33 ft. high, and five additional towers 46 ft. in diameter and 33 ft. high, comprise the installation. The last tower is an open-air, all-steel structure (German patent No. 490,078). As this tower has been in operation for a long time with no sign of corrosion ever being in evidence, the problem of using steel in the construction of the Gay-Lussac plant may be considered satisfactorily solved. As the diameter of the towers exceeds the height, a correct choice of packing material results in an ideal low resistance whereby completely uniform gas distribution over the 1,600 sq.ft. cross-section has been made possible. During the past year the average production was 100 tons of 60-deg. acid, with a nitric-acid consumption below 1 per cent.

• • • Difficult conditions also prevail in a plant in the Urals, where gases from a water-jacket furnace are being treated. Sulphur-dioxide content varies between 1 and 3 per cent, averaging 1.7 per cent, and the gas is frequently contaminated with free sulphur, as the furnaces must be operated with a small volume of air. In addition, the gas contains carbon monoxide and carbon dioxide. Whereas the latter, like the nitrogen in the air, acts only as a diluent, the monoxide has a disturbing effect on account of its affinity to the nitrous vitriol.

As the reactions are carried out exclusively in towers, and without the use of mixers or similar equipment, operation as well as attendance is simple and cheap. Several additional advantages are obtained in installations of large size. Installation costs are greatly reduced and operating costs substantially lowered. Table I gives the relative construction cost per ton output of 60-deg. acid, for plants of varying sizes. These figures, although based on German conditions, may be assumed to be fairly proportionate for installations in other countries.

Table I—Output and Construction Costs

Daily Output in Metric Tons	Construction Cost per Ton, in Marks
40	12,700
100	8,200
250	5,800

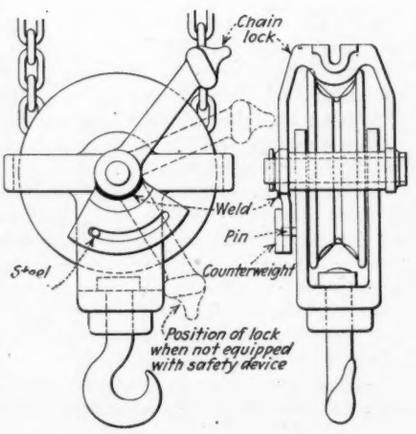
The cost of producing 100 tons of 60-deg. sulphuric acid daily, assuming gas of normal conditions, and disregarding roasting cost and cost of pyrites is as follows:

Table II—Operating Costs

	Marks
Wages, 24 hrs. @ 1 mark	24.00
Proportion of attendance	10.00
Nitric acid (1.1 per cent), 2,500 lb. @ 5.30 marks	132.00
Power for pumps, blower, and light, 2,000 kw.-hrs. @ 0.04 marks	80.00
Water	30.00
Repairs	50.00
Interest and amortization, 15 per cent on a first cost of 820,000 marks	342.00
Cost of 100 tons	668.00
Cost per ton	6.68

General overhead charges are not included in this figure.

Safety Device for Chain Sheaves



UNGUARDED chain locks on the pendant sheave carrying the swivel hook of differential chain hoists are frequently responsible for injuries to the hands. When not equipped with a counterweight, or a similar arrangement, the heavy lock lever will drop suddenly upon release of the chain link and hit against the hook support, thus presenting a hazard to the operator. An efficient device that has assisted greatly in reducing accidents in the machine shop at the mine of Moctezuma Copper, at Pilares, Sonora, Mexico, is shown in the accompanying illustration. The fall of the lock lever is checked by the welded-on, balanced device, controlled by a steel stop pin attached to the hook support and the semicircular slot corresponding in length to the distance required to clear the chain.

The Empire Zinc Company's Operation at Gilman, Colorado

[PART II]

Prepared by the technical staff of the company under the direction of

W. O. Borcherdt

A large underground mill of ingenious design solves a difficult metallurgical problem imposed by unusually rugged topography and a severe winter climate. The details of construction and operation given herewith constitute the second of a series of articles on the operations of The Empire Zinc Company, a subsidiary of The New Jersey Zinc Company

AT THE Eagle mine of The Empire Zinc Company—subsidiary of The New Jersey Zinc Company—situated at Gilman, Colo., 27 miles west of Leadville, the zinc-lead ores vary in relative proportion of the several minerals, structure, particle size, hardness, degree of attachment, and oxidation. A marked porosity characterizes much of the ore. This ranges from distinct "rubble" ores containing boulders of ore and gangue, either in a loose mass or firmly cemented but with a large percentage of voids, to types in which a considerable volume of voids prevails, even though the individual grains are small and the ore is strong. Some of the ores are massive and compact and often banded, but probably about 15 per cent of the ore in place is void space. This characteristic contributes to the difficulties of flotation by facilitating superficial oxidation with consequent production of water-soluble salts and salts less soluble, which appear as tarnish or coatings on certain minerals, especially galena.

The ore is essentially pyrite, with varying amounts of sphalerite, galena, siderite, calcite, dolomite, chalcopyrite, and small quantities of many other minerals. The pyrite ranges from hard, bright, coarsely crystalline to fine-grained massive, and varies also in hardness and resistance to oxidation. Sphalerite ranges from practically pure, light-colored blende to marmatite, but blende low in ferrous iron is rare, and most of it must be classed as marmatitic. In small fragments it is dark red by transmitted light; almost black in mass form; and brown as flotation concentrate. The blende commonly contains microscopic inclusions of chalcopyrite.

Galena varies from coarsely crystalline to the fine-grained, "steel" variety. It is generally tarnished or even heavily coated with oxidation products which give it a dull, bluish-gray appearance. The siderite is a mangano-magnesian variety. It ranges from white, through yellowish brown or gray, to black, depending upon the degree of oxidation. Chalcopyrite is a minor mineral occurring in the zinc-lead ores.

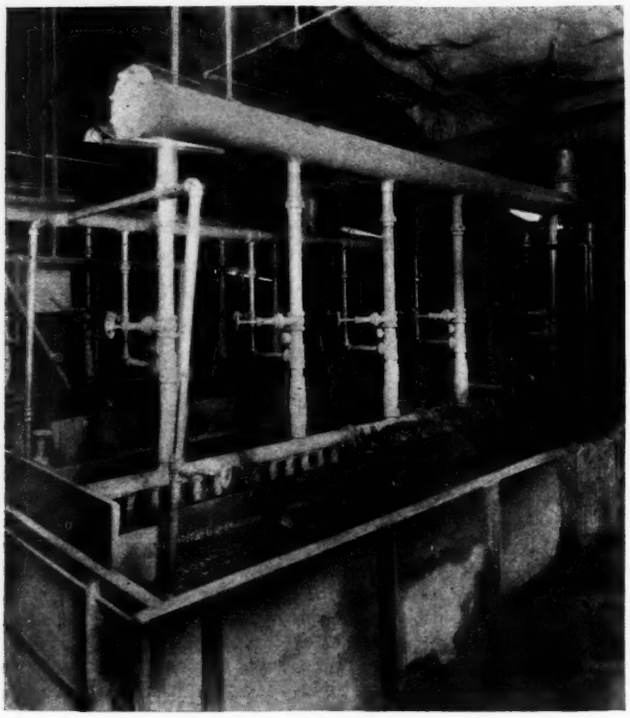
The original mill of the Eagle Mining & Milling Company, at Belden employed a magnetizing roast, following which the pyrite was removed by low-intensity magnetic separators and the separator tailing tabled to produce lead and zinc concentrates. After the mine had been acquired by The Empire Zinc Company, the ore was concentrated at a new mill built at Canon City, Colo. This mill treated also a large number of similar ores purchased or mined in the district. Before the development of differential flotation the plant represented the most elaborate and successful effort to treat the so-called complex zinc-lead ores. At different times during its relatively long life, a number of treatment schemes were used, but, in general, the method employed was based upon the fact that, although unroasted pyrite is practically non-magnetic, the marmatitic blende has low-magnetic susceptibility, which permits its removal upon high-intensity magnetic separators of the Rowand-Wetherill type. These machines were developed to a highly successful degree and their utility was unquestioned until the art of differential flotation at last came into its own.

In the Canon City mill the ore was dried at low temperature; crushed, with a minimum production of fines; carefully sized with screens; and fed to a large battery of Rowand-Wetherill magnetic separators. These lifted off, successively, zinc concentrate and zinc middling. The tailing was either tabled for recovery of the lead or flash-roasted and run over low-intensity magnetic separators, which removed the bulk of the pyrite, and then tabled for recovery of the lead. The methods and machines used in the Canon City mill had much to justify their long and useful life, but they were abandoned when better grades and recoveries by flotation became possible.

During the last few years of its operation the Canon City mill included a small flotation plant which treated dust and middling products from the magnetic separator plant. As the material supplied to this plant had all been dried at some time in its prior treatment, it was not desirable flotation feed. Results, although passable under the circumstances, were not representative of what could be accomplished by flotation on raw ore.

In preparation for the change in milling methods the mine was carefully sampled, and a set of large samples was prepared which was fairly representative of the ore in sight at that stage of development. A weighted composite was made from these. Tests were then conducted upon the composite sample and also upon the individual samples, so that the effect of range in mineralogical composition might be made clear.

Ore-dumping station on the Newhouse tunnel level



Part of the lead-flotation section illuminated by mercury-arc lamps

Microscopic examination, hand-sorting tests on sizes susceptible to such examination, and experience gained in milling the ore gave a fair idea of what might be expected in mineral associations, degree of attachment, and natural grain sizes. That these factors, even though fairly accurately determined at the outset, might change with further development of the mine was realized. This information, however, has been useful not only in the original design of the plant but also by providing an approximate standard of reference for comparing changing conditions.

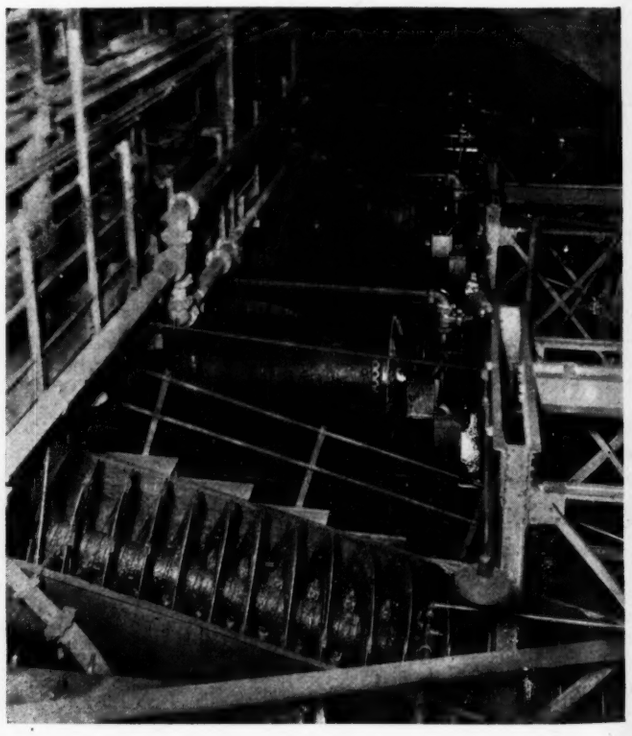
To determine the possibilities in initial gravity concentration for recovery of galena, a rather elaborate set of tests was made. A hydraulic sorting tube was used with closely sized material, and a laboratory jig of special design with material sized through a ruling opening to about the degree of sizing that appeared to be practicable in the mill. The relative value of the sorting tube and that of the laboratory jig were established by making with them a series of tests under the conditions stated on another ore which was being successfully treated by Hancock jigs and tables for initial removal of galena. These tests showed a satisfactory correspondence between the results obtained in the mill and those obtained with the testing devices, and gave confidence that the results of the tests on Eagle ore could be translated into practice with reasonable accuracy.

The combined results of the microscopic examination, the hand-sorting tests, and the tube and jig tests showed that for reasonably good recovery and grade of gravity lead concentrate it would be necessary to crush the ore to pass $\frac{3}{8}$-in. square holes (Tyler No. 4) or to pass $\frac{1}{4}$-in. square holes (Tyler No. 3) and recrush a larger quantity of jig middlings.

While the aforesaid tests were in progress the flotation treatment of the ore was undergoing further investigation. A set of general mine samples was submitted to the General Engineering Company, of Salt Lake City, Utah, for testing, and another set was tested in the laboratory by the engineers of The Empire Zinc Company. Both sets of tests indicated that the major flotation difficulty would be with the galena, which accorded with previous experience in the small Canon City flotation plant.

Following these laboratory flotation tests the Canon City plant was altered to a pilot plant for straight differential flotation. The ore treated was freshly mined and had not passed through the dryer. Results resembled closely those obtained in the laboratory straight-flotation tests; that is, the results on zinc were satisfactory but those on lead were not.

Difficulty with the galena was determined definitely to be caused by the coating or superficial oxidation, which existed in varying degree in all the ore as it came from the mine and was increased but not caused by the ore aging in storage and by drying it. In anticipation of such a conclusion, the testing for gravity roughing of galena had been done, and the Canon City pilot plant altered by the addition of a feed bin and concentrating tables so that galena could be roughed out before grinding and flotation. The pilot plant was then run again for several months, and the results obtained justified the conclusions. Although not uniformly good, because of the difficulty of maintaining in so small a plant the requisite balance of all factors necessary for good flotation, they averaged far better than any previous results over similar periods on similar feeds. The best periods showed results on zinc equal to the results obtained in the company's laboratory or in the General Engineering Company's tests; and on lead they



Rod mills and classifiers on one of the upper mill floors

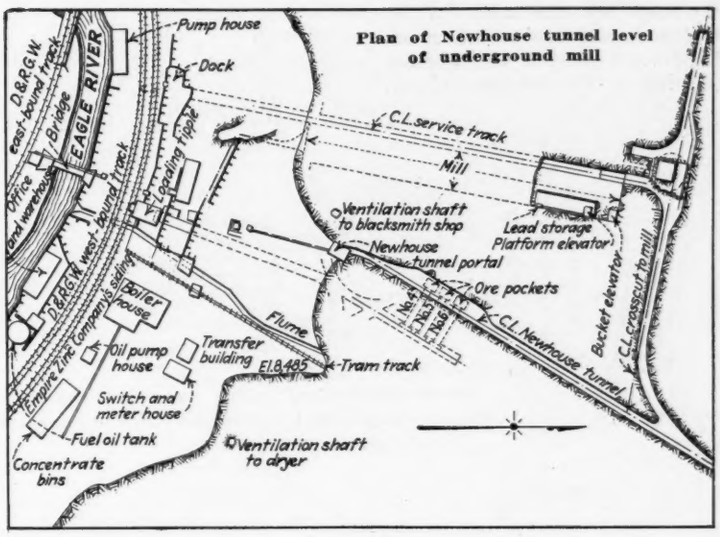
showed results of a superior character.

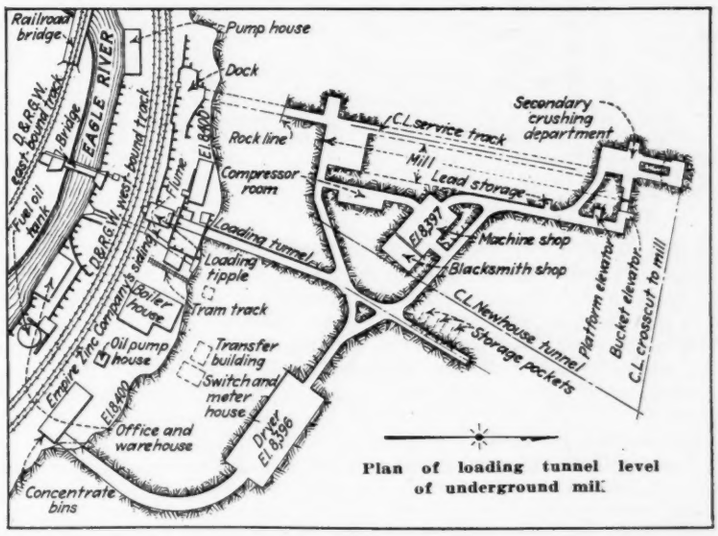
The tests determined that the soluble-salt content of the ore, because of the porosity of the ore and the relative ease of oxidation of some of the mineral, was high and quite variable and capable of exerting a marked and irregular effect on flotation. A wide variation was found in the galena content in different parts of the mine that greatly affected the zinc-lead ratio, inasmuch as the zinc was much less variable. Moreover, the galena was found to be quite generally tarnished or coated with insoluble reaction products which seriously affected its flotation. It could, however, be separated by gravity to an extent sufficient to steady the zinc-lead ratio for flotation and to reduce greatly the amount which would have to be floated. Good water was available in necessary quantity and would not have to be pumped high.

On the basis of these considerations the flowsheet was evolved for the design of the new mill. It included a preliminary washing of the ore after crushing to about ½-in., using a minimum quantity of water for the removal of soluble salts, wood pulp, and such colloidal matter, as gouge, free at that size. The ore would be crushed to pass through screens with ¼-in. square openings, and then classified; the coarse sands would be treated on a Hancock jig, and the fine sands and slimes on roughing and finishing tables to make lead concentrate. The gravity tailing would be ground, thickened, decolloided, and floated differentially to produce lead and zinc concentrates.

Inasmuch as this article is intended to be descriptive of the milling plant, to expand metallurgical detail is unnecessary, further than is required to show the connections between cause and effect—that is, the conditions which affected the design of the plant. In some respects the original objectives have not yet been attained, whereas in others they have been passed, and new and higher objectives have been set. So far it has not been found desirable to change the original plan of treatment, but perfection has not been reached with present recovery of 90 per cent of zinc and lead in their respective concentrates, and changes will naturally be made as they are found to be expedient.

During the progress of the testing work upon which the flowsheet of the proposed mill was to be based, topographical surveys and field studies were made to determine the best situation for the mill and tailing pond. Preliminary studies ruled out Canon City as a site, the 160-mile haul under the most favorable circumstances being too much for the ore to bear, although many other conditions there were advantageous. The site of the old mill at Belden was given careful thought, but the space available there was barely sufficient for the auxiliary structures which would be required.





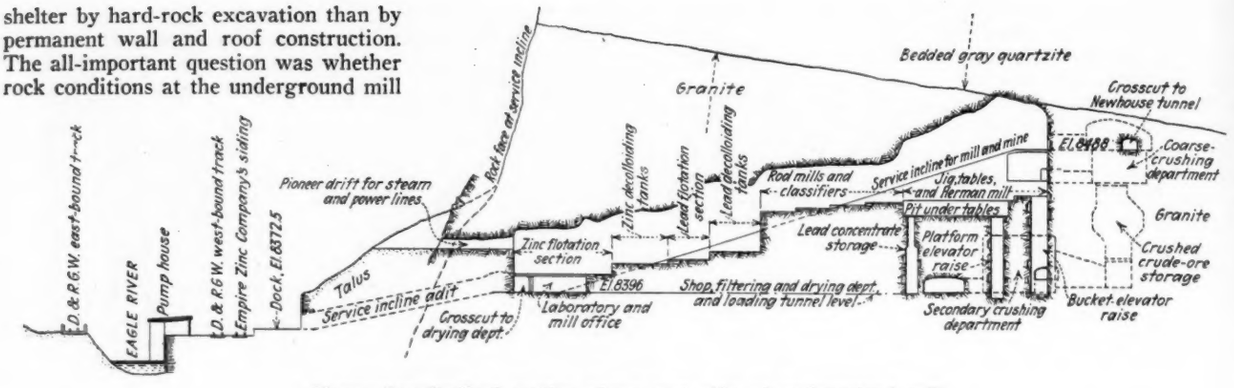
At Rex, about two miles down the Eagle River from Belden, the canyon opens out into a valley which offered several possible sites, and these were studied. The most favorable was alongside the bench on which the railroad is placed, where a difference of elevation of 35 ft. existed between the railroad grade and the meadow. A topographical map, with 1-ft. contours, was made of this site; test pits were sunk to determine the character of the ground, and finally computations were made of cuts and fills, concrete yardage, trackage, and supporting steel. A freight rate on crude-ore shipments from Belden to Rex was secured, a schedule of movements prepared, and an estimate made of the cost of construction and of operation of the proposed plant.

The favorable and unfavorable factors were thus thrown into strong relief, and study was concentrated on the effort to overcome the unfavorable items. Of these the most serious were the necessity for pumping tailing; extensive filling to provide adequate crude-ore, concentrate, and supply sidings; the difficulty in securing at Belden the necessary siding space and grades for handling crude ore; the expense of providing a large number of hopper-bottom ore cars; and the administrative and residential difficulties involved in separating the mill so far from the mine at Gilman and from the town of Redcliff. The severe climate and heavy snowfall complicated some of these problems, and the net result was an estimate of construction and operating cost which was not attractive. At this juncture the plan of constructing the mill underground was suggested and a study of the project was made for comparison.

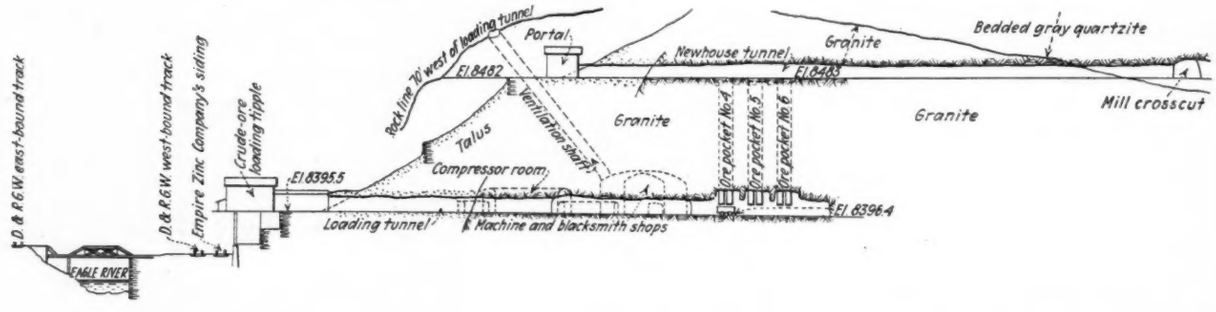
So far as we know, only one mill, and that a small one[1], had been built underground. Numerous pumping stations, hoisting stations, drill shops, and even power plants had been successfully built and operated underground, and our own experience elsewhere had shown that under good rock conditions, and with proper facilities for drilling, blasting, and removal of débris, it was cheaper to prepare a given volume of

[1] *Engineering and Mining Journal*, Vol. 107, No. 26, p. 1,130, June 28, 1919.

shelter by hard-rock excavation than by permanent wall and roof construction. The all-important question was whether rock conditions at the underground mill



Above—Longitudinal section along east side of underground mill
Below—Longitudinal section through Newhouse and loading tunnels



site were such as to justify the project. This, fortunately, was fairly easy to determine in a general, but not in a detailed way, because the Newhouse tunnel penetrated the formation near where the top of the mill would come and the loading tunnel near where the bottom would come.

The mass of rock in question is the upper part of the Pre-Cambrian granite, on the old, eroded top of which lies unconformably the white Cambrian quartzite. That slips and cleavage planes prevailed in the granite, and considerable kaolinization near its top, was known, as well as that the rock was hard, blocky, and difficult to drill and blast, which characteristics would result in considerable overbreakage, besides rough and irregular surfaces. Although these difficulties would increase expense, the consensus of opinion was that openings of the required size could safely be made and maintained. Some drilling was done to determine the position of the granite-quartzite contact, and data relating to the rock mass were assembled on a drawing. The desired openings were fitted within the limits as well as could be anticipated, and plans of the necessary excavation made. As the preliminary figures were much more attractive than those prepared for the project at Rex, even after making allowances for the uncertainties attending such an undertaking, and as the advantages of the underground mill project were more fully developed by detailed study, a decision was made to proceed with the design of the underground mill, and its construction was authorized.

As already stated, two tunnels were available around which the project was developed; these remain unchanged. The upper or main adit entrance to the mine is known as the Newhouse tunnel, and the lower, which connects with a tipple above the railroad siding, is known as the loading tunnel. The floor of the loading tunnel is about 27 ft. above the siding grade, and the Newhouse tunnel floor about 87 ft. above the loading tunnel floor. Center lines of the two tunnels are parallel, the center line of the Newhouse tunnel being 47 ft. northwest of that of the inner end of the loading tunnel. Between the two tunnels are three large ore pockets cut in the granite. These are used for the storage of pyritic ore prior to its shipment to the smelter. Formerly, both pyritic ore and zinc-lead ore, which was shipped to the Canon City mill, were stored in the pockets. The Newhouse tunnel, at its inner end, connects with the main 16-level haulageway of the mine, which connects near by with the "Chief" incline and the No. 1 or "Wilkesbarre" vertical shaft. It has a fairly uniform grade of about 1 per cent, and serves also for ventilation and mine drainage purposes.

Approximately 460 ft. from the portal of the Newhouse tunnel a crosscut was driven to the west, and about 258 ft. from the Newhouse it was expanded into a large room which forms the top of the coarse-crusher station. Its center line is about 42 ft. west of the center line of the main mill room, provision thus being made beneath it for the coarse crusher, the ore bin, and the fine crusher, to serve not only the present mill but also a possible future duplicate of the present plant.

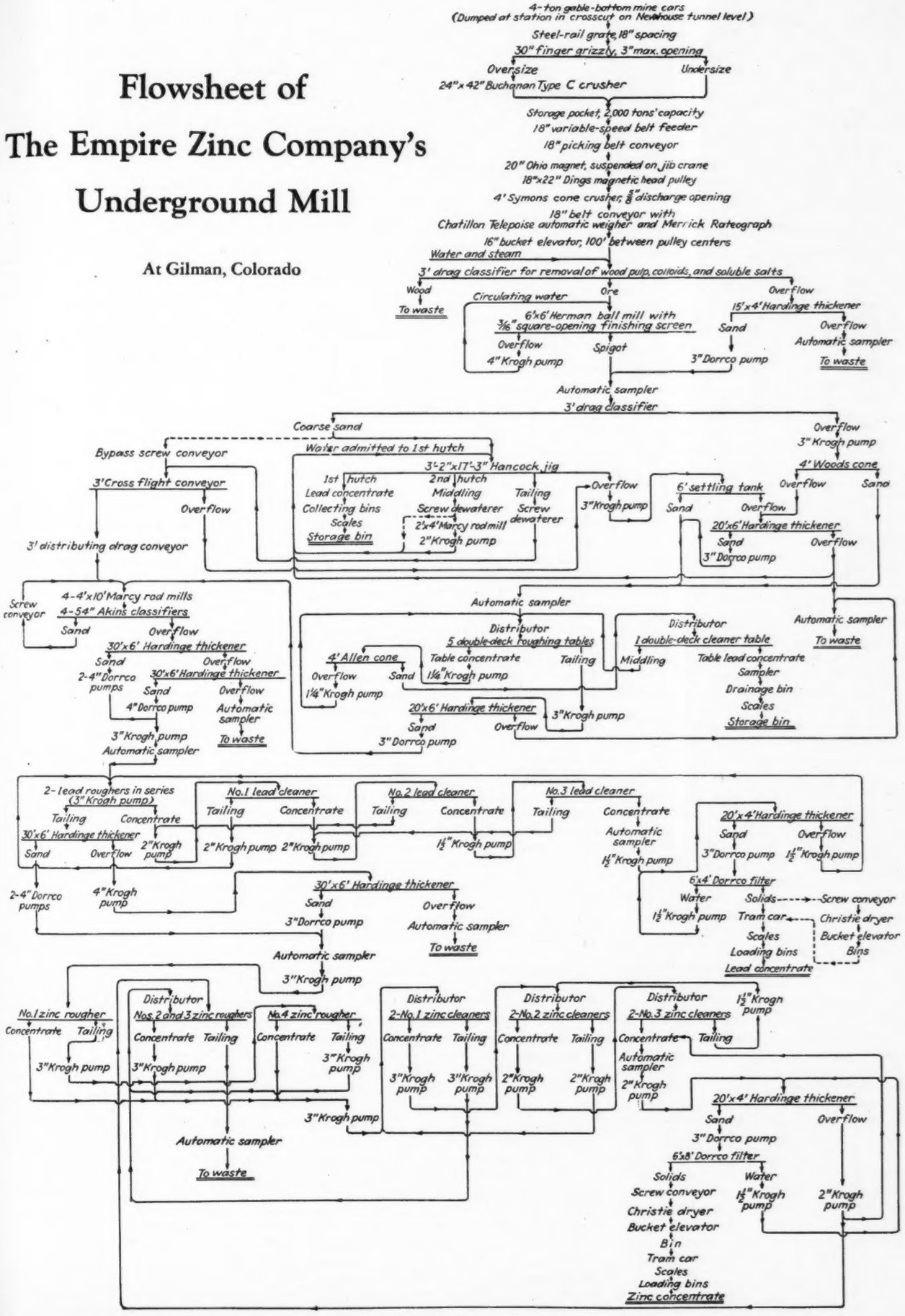
The main mill room is 330 ft. long and 52 ft. wide, 10 ft. of its west side being devoted to a service incline. This incline, with a slope of 18 deg., runs from a loading dock at the railroad to the coarse-crusher crosscut from the Newhouse tunnel and connects also with a drift at the lower end of the mill, which is at the elevation of and connects with the loading tunnel. The upper end of the mill room connects with the coarse-crusher station below the Newhouse tunnel level by means of a short drift.

Below the coarse-crusher station an ore pocket, with a capacity of 2,000 tons, was cut in the rock, and below it, with its floor at the loading-tunnel level, is a fine- or secondary-crusher station, which connects by means of a drift with the loading tunnel. The fine-crusher drift forms the base of four raises to the mill room. One was used only for construction and is now closed off. The others were also used for construction, but one now serves as storage for jig and table lead concentrate, another for an Otis electric elevator for men and materials, and the fourth for the main-mill bucket elevator, which lifts the crude ore from the fine crusher to the head of the mill room.

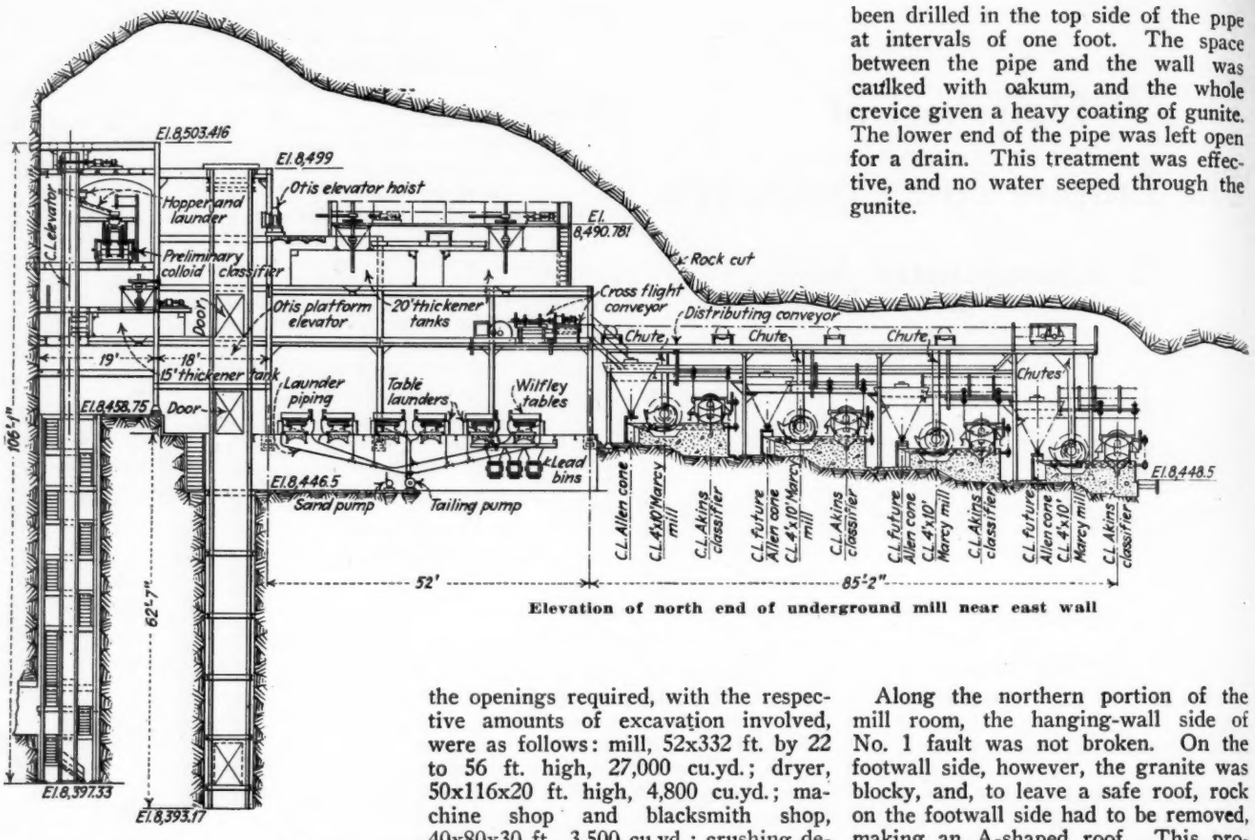
On the loading-tunnel level, and connected therewith by drifts, a 45x20-ft. room was excavated for the Allen blowers, which supply flotation air; an 80x40-ft. machine and blacksmith shop; and, to the east of the loading tunnel and the lower end of the mill, a 116x50-ft. filter and dryer room. This room

Flowsheet of The Empire Zinc Company's Underground Mill

At Gilman, Colorado



been drilled in the top side of the pipe at intervals of one foot. The space between the pipe and the wall was caulked with oakum, and the whole crevice given a heavy coating of gunite. The lower end of the pipe was left open for a drain. This treatment was effective, and no water seeped through the gunite.



Elevation of north end of underground mill near east wall

connects at its east end with a curved drift which comes out of the face of the canyon wall to connect with the housing above the concentrate bins.

The blacksmith shop end of the machine shop is connected to the surface by a raise, through which the gases and ventilating air from the shop are discharged by a fan. A similar raise, also about 100 ft. high, serves as a stack for the gases from the concentrate dryers; but it is operated by natural draft. These raises have at their upper ends louvered concrete structures to protect them against entrance of rain and débris. Details of arrangement of the main underground rooms are presented in the accompanying drawings.

Surface structures at Belden include the No. 4 substation, with its brick and concrete switch and meter house; a steel and concrete boiler house, sheathed with corrugated "transite" sheet; gunite-covered, insulated, steam-heated, reagent storage tanks; a brick and concrete pumping station; wooden loading tipple; wooden building used as a supply house and temporary mill office; 50,000-gal., gunite-covered, insulated, steam-heated, fuel-oil storage tank and its pump house, serving boiler and dryer furnaces; steel concentrate bins, with galvanized, corrugated-steel housing; and a compressor house that contains the 100-lb.-pressure air compressors and an emergency alternator driven by a Pelton wheel. The accompanying drawings show the relation of these elements to the rest of the plant and the railroad.

In constructing the underground plant, the openings required, with the respective amounts of excavation involved, were as follows: mill, 52x332 ft. by 22 to 56 ft. high, 27,000 cu.yd.; dryer, 50x116x20 ft. high, 4,800 cu.yd.; machine shop and blacksmith shop, 40x80x30 ft., 3,500 cu.yd.; crushing departments and storage facilities, 4,700 cu.yd.; drifts and raises, 8,000 cu.yd. The mill yardage includes the blower room. Crushing departments and storage facilities include the station above the rough crusher, rough-crusher room, storage pocket, and fine-crushing room. Drifts and raises include about 1,100 ft. of 8x10-ft. drifts and the service incline from mill to platform at railroad siding, through old fill and supported with steel sets. In the main mill room raises were put up connecting with an inclined drift which was driven from one end of the room to the other near the top. This drift was widened and the roof formed and trimmed. The bottom was then taken up with jackhammers and the rock disposed of by scraping to the raises.

All the work was in granite. In the upper part of the mill room quartzite was exposed over a small area. This resulted from overbreaking in poor granite. Several faults were encountered in the main mill room. These necessitated the removal of a larger quantity of rock than had been planned. The fault known as No. 1 came in on the west, near the south end, and extended diagonally across the mill room, passing out in the east wall, near the north end. It had a dip of 50 deg. to the east. Along part of its length water seeped. To prevent any possible future trouble from this water, gouge and loose rock were picked out of the fault to a depth of 6 in. and a lead pipe was inserted throughout the length of the crevice. Holes, ½ in. in diameter, had previously

Along the northern portion of the mill room, the hanging-wall side of No. 1 fault was not broken. On the footwall side, however, the granite was blocky, and, to leave a safe roof, rock on the footwall side had to be removed, making an A-shaped roof. This procedure keyed in the blocky ground, which would have been heavy had the roof been left arched as originally intended. The same conditions existed along the other two faults, and a similar modification of the original roof profile was necessary in each instance.

A summary of the drilling equipment employed follows: For drifting, Gardner-Denver Nos. 7 and 17 drills, with 1¼-in. round hollow steel; down holes, Ingersoll-Rand No. X-59 Jackhamers, with 1¼-in. round hollow steel; block-holing, Gardner-Denver No. 11 jackhammers, with ⅞-in. hexagon hollow steel; raises, Gardner-Denver No. 77H stopers, with ⅞-in. hexagon hollow steel.

The following handling equipment was used: Two Conway shoveling machines; three Lake Shore Engine Works double-drum scraper hoists, with 20-hp. motors and scrapers 4 ft. wide; one Sullivan double-drum HDA-2 air hoist, with scraper 30 in. wide; two Atlas 1½-ton storage-battery locomotives; one Baldwin-Westinghouse 5-ton storage-battery locomotive. These locomotives, together with all other electric locomotives used at the property, are equipped with Edison storage batteries. The Conway shovels were used in all drifts, in the dryer room, machine shop, south end of fine-crusher room, rough-crusher station, and in the south end of the mill room. Scrapers were employed in part of the fine-crushing room, the blower room, and in the mill room. In the main mill room the scrapers were pulled into raises and chutes: one at the south end, one in the center of the mill, the

lead-concentrate raise, and the freight-elevator raise. Practically no hand shoveling was done. Gable-bottom side-dump cars of 50-cu.ft. capacity were used for hauling from the shoveling machines and raise chutes, the waste being dumped direct into railroad cars. The waste was used by the D. & R.G.W. railroad for construction purposes along its tracks in Eagle River Canyon.

All excavation was done by the E. J. Longyear Company, of Minneapolis, Minn., on a cost-plus basis. The Empire Zinc Company furnished all material and equipment, which became the property of Empire Zinc on completion of the work.

In preparing the final rock surface of the various rooms, holes parallel to the direction of the sides or the roof, with light burden, were drilled on line and charged with only sufficient powder to break the rock. After the holes were fired all loose rock was removed with bars and wedges, so that further fracturing of the blocky granite might be avoided. The back of each room was thoroughly washed and inspected. Gunite was then applied, being built up in several layers to whatever thickness conditions required. The walls were given the same treatment where it was necessary. Staging was used to reach the roof, which was 75 ft. above the floor at some places, owing to overbreaking. In constructing the staging, 2x6-in. boards on 7-ft. centers were used for posts. These were well braced, and a solid floor was laid on them about six feet below the roof. Carpenters were kept on the job to move the flooring as the work progressed and to inspect the staging for loose boards. Staging for the entire mill was erected in eight days.

Clean sand for guniting was obtained from the Fountain River, at Pueblo, Colo. The sand was sized through a $\frac{3}{8}$-in. screen, and a $3\frac{1}{2}$ to 1 mixture of sand and portland cement was used. Two Cement Gun machines were operated on a two-shift basis. The sand was dried alongside the railroad and dry-mixed with cement in a concrete mixer, the resulting mixture being placed in cement sacks. These were filled to two-thirds of their capacity to facilitate handling. Each gunite machine used 600 of these sacks per eight-hour shift. The crew of each machine comprised four men. A gunite coating $\frac{1}{4}$ in. thick was applied on flat faces of the rock, and a coating up to 6 in. thick in cracks and on irregular surfaces.

After the mill was completed and in operation, the entire mill room, walls and roof, was whitewashed with a mixture consisting of 5 lb. casein, 3 lb. trisodium phosphate, 50 lb. hydrated lime, 3 pints of formaldehyde, and 25 gal. of water. After being mixed in a cylinder container, the whitewash was applied by air pressure through a $\frac{1}{2}$-in. hose equipped with a nozzle.

The floors in all the openings are concrete, except those in the drifts, which have been covered with reject material from guniting. Floors slope to sumps, where pumps remove water that accumulates. Concrete foundations were reinforced where necessary. All concrete work was done by the Hamilton & Gleason Contracting Company, of Denver, Colo., on a cost-plus basis, the company also receiving rental payments on certain items of equipment. The structural steel used was detailed and fabricated by E. Burkhardt & Sons, of Denver, Colo., but erected by Empire Zinc.

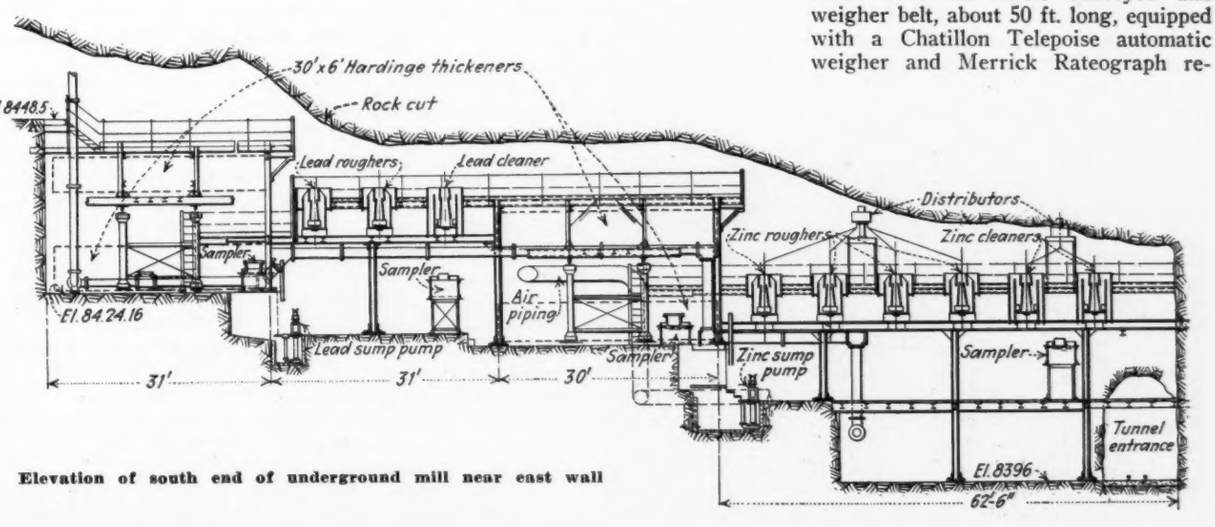
As indicated in the accompanying drawings and flowsheet, a crosscut was driven from the Newhouse tunnel to the upper end of the mill drift, where a dumping station for the gable-bottom and end-dump mine cars has been installed. This station is situated directly above the coarse-crushing plant, rail grids allowing the passage of rock of 18-in. maximum size.

From the dumping station the ore passes over a finger grizzly, consisting of cantilever manganese-steel fingers that taper from 4 in. down to about 2 in. This grizzly is set at a slope of 30 deg. and allows passage of ore particles up to 3 in. in diameter. A chain curtain is suspended above the bars at the lower end to retard the fall of rock across the bars and to remove a greater portion of fines, which drop behind the crusher directly into a 2,000-ton storage bin.

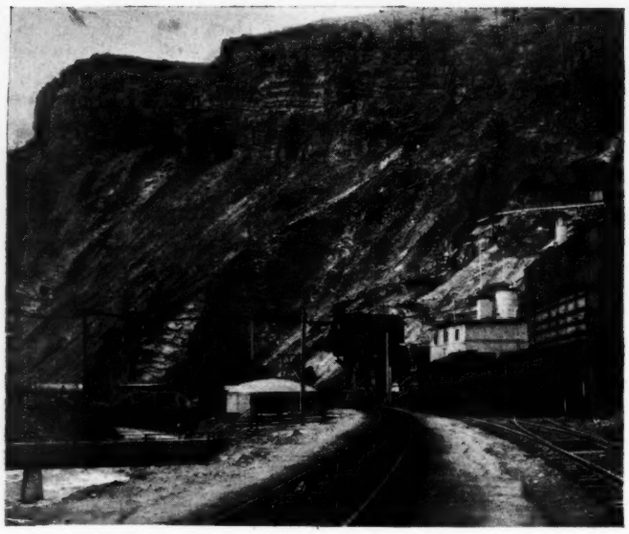
Oversize from the grizzly falls into a Type C, 24x42-in., Buchanan jaw crusher, set to crush to 3 in. The crusher product passes into a storage bin, where it joins the undersize from the grizzly. A 100-hp. G.E. slip-ring motor drives the crusher through a James herring-bone speed-reducing transmission, with a DeLaval flexible coupling. This unit is operated whenever a trainload of ore is received from the mine. Ten 4-ton cars of ore comprise a train, this quantity of ore passing through the crusher in about fifteen minutes.

The storage bin for the coarse-crushing plant consists of a raise between the primary and secondary crushing units. This raise has a storage capacity of 2,000 tons and a steel hopper bottom. Ore is drawn from the bin by means of a belt feeder, consisting of a conveyor belt about 10 ft. long and 18 in. wide, held at a constant elevation by closely set idlers and passing directly under the storage bin hopper in such a manner that the forward movement of the belt causes discharge of ore from the bin. The amount of ore discharged depends on the size of the opening in the bin hopper and on the speed of the conveyor, both of which are adjustable. A 2-hp. G.E. motor drives the feeder belt through a No. 00 Reeves variable-speed transmission.

From the feeder the ore drops onto a short 18-in. conveyor belt, used also as a wood-picking belt, which is equipped with a 20-in. Ohio magnet, suspended on a jib crane, and an 18x22-in. Dings magnetic head pulley. The conveyor carries the ore to a 4-ft. Symons cone crusher, with a $\frac{5}{8}$-in. discharge opening, which is operated by a 40-hp. motor through a Texrope drive. The product of the crusher drops through a short chute onto an 18-in. conveyor and weigher belt, about 50 ft. long, equipped with a Chatillon Telepoise automatic weigher and Merrick Rateograph re-



Elevation of south end of underground mill near east wall



Belden in Eagle River Canyon. Concentrate bins at the right

corder. This conveyor discharges into the boot of a bucket elevator, known as the mill elevator, which raises the ore from the secondary crushing plant to the top of the mill room. The elevator is 100 ft. high, and consists of 16-in. 7-ply rubber-covered belting, with 14x6-in. buckets, spaced 30 in. apart. The housing is of steel construction throughout. A separate motor drives the elevator through a Jones speed reducer, a belt speed of 350 ft. per minute being employed.

The mill elevator discharges the ore, crushed to $\frac{5}{8}$-in., into a drag classifier, which is used for preliminary washing of the ore for removal of wood chips, water-soluble salts, and detrimental colloids. Component parts of the drag comprise steel flights, 4 in. wide, $\frac{1}{2}$ in. thick, and 3 ft. long, attached at intervals of about 12 in. to two No. 124 Ewart-type manganese-steel chains. The tank bottom is made of sheet steel, reinforced with waste rods from the Marcy mills and set in Lumnite cement. A V-shaped pattern is used in placing the rods, the point being toward the discharge end of the drag, to prevent any possibility of the drag catching on the rods and tearing out the bottom.

This drag classifier, the elevator, as well as the two conveyor belts and feeder, are all driven by individual motors, with switch controls for these units placed on the Herman-mill floor, so that the feed can be cut off if necessary. Signal lights are installed at the belt feeder and at the upper end of the mill and flotation section. These show the hourly tonnage at the feeder and indicate when the feed has been cut off or started at the feed belt.

A Herman peripheral-discharge screening ball mill, built under patents owned by the Braun Corporation, of Los Angeles, Calif., is used for reducing the size of the ore from $\frac{5}{8}$ to $\frac{7}{16}$ in., at which size the ore is treated in the gravity section of the mill. This mill, which is the 6x6-ft. size, consists of two manganese-steel heads, 6 ft. in diameter, with large trunnions. The feed is passed through the two trunnions by manganese-steel radius bends. Half of the ore reaches the mill through each trunnion, and is discharged through the screen surface of the mill drum. Bolted to the mill heads are six curved manganese-steel grid plates, which form the drum. These plates are perforated with $1\frac{1}{2}$-in. slots, V-shaped in cross-section, with a 3-in. opening inside to provide a gradually decreasing opening and to prevent wedging of balls. They are covered with a base screen of $\frac{7}{16}$-in. double-crimped steel wire, with 0.625-in. openings. The base screen is drawn tight, welded at the joints, and covered with a finishing screen of 0.192-in. double-crimped steel wire, with 0.187-in. openings. The finishing screen is placed directly over the base screen. It is drawn tight and held in place by welded joints and four $\frac{1}{4}$x6-in. steel straps, with draw bolts. At present the mill is operated with a charge of 18,000 lb. of 4-in. steel rods, which apparently gives a coarser discharge product and more capacity than a similar ball charge.

The screen discharge from the mill falls into a hopper equipped with an adjustable discharge spigot for regulating the pulp density of the final product. Overflow of the hopper is in closed circuit with the mill through a 4-in. Krogh pump. As the spigot discharge is about 55 per cent solids and the bulk of the water is circulated, comparatively little make-up or fresh water is required to keep the mill in operation. The mill grinds everything through the ruling size of the finishing screen, with a minimum production of fines. A 100-hp. G.E. slip-ring motor operates the mill through a Texrope drive, with variable-speed regulation by means of resistance grids. The speed range is from $7\frac{1}{2}$ to 12 r.p.m., with a usual speed of from $7\frac{1}{2}$ to 9 r.p.m. on a mill feed of $27\frac{1}{2}$ tons per hour.

Thickened pulp from the Herman mill drops through an automatic sampler directly into the jig and table classifier. The purpose of this unit is to divide the pulp into a coarse product, suitable for separation on the Hancock jig, and a fine product for treatment on the double-decked tables. The sand discharge from the classifier passes directly to the feed end of the 12-ft. 3-in.x3-ft. 2-in. Hancock jig, equipped with a screen having 0.194-in. openings. No. 00 lead shot are used for bedding on the concentrate hutch, and $\frac{7}{16}$-in. steel balls on the middling hutch. The jig operates at a speed of 189 strokes per minute and makes a product containing 60 to 70 per cent lead.

The jig middling and tailing are removed from the hutches by means of vertical screw dewaterers, consisting of conveyor flights, 9 in. in diameter, and made of a spiegel-iron mixture, rotating in a 10-in. pipe of the same material. Short horizontal screws, called gathering screws, placed in the bottom of the jig hutches, force the products into the vertical screws. The jig middling is returned to the feed end of the jig, either direct or via a 2x4-ft. Marcy rod mill, and the tailing is discharged into a drag conveyor, locally called the cross-drag conveyor, which delivers the tailing to the main distributing drag conveyor, above the Marcy mills. Concentrate is drawn from the jig concentrate hutch through a molasses gate, run into wheelbarrows, drained, sampled and weighed at the end of each shift, and dumped into a storage raise, which also serves as a shipping bin.

The classifier overflow is forced by a 3-in. Krogh pump to a 20-ft. Hardinge thickener, the sands passing through a distributor to five double-deck tables which make a rougher concentrate and tailing product. One double-deck table re-treats the concentrate, making a finished concentrate and a middling product, which is returned to the rougher feed. Rougher tailing is forced by another 3-in. Krogh pump to a second 20-ft. Hardinge thickener, the sand discharge of which, with the jig tailing, forms the Marcy mill feed.

Liquid reagents, such as oils and sodium silicate, are stored in four horizontal 15,000 gal. storage tanks, situated in the canyon, alongside the railroad. They are equipped with an auxiliary tank which can be filled from the storage tanks and emptied to tanks at the head of the mill room by compressed air. Dry reagents, such as caustic soda and soda ash, are stored in the mill, and taken into solution for daily use in four 1,000-gal. mixing tanks with water and steam. The four mixing tanks are supplemented by two horizontal 3,200-gal. storage tanks, placed in the upper end of the mill room, from which pipe lines are run to points where the reagents enter the mill circuit.

Hardinge thickeners are used exclusively for thickening the mill pulp. A 15x4-ft. tank, equipped with a Hardinge mechanism, is used for thickening the overflow of the primary colloid classi-

fier. This tank, which has a rake speed of 0.25 r.p.m., is driven by a 2-hp. G.E. motor through a Jones speed reducer. The rake-lifting mechanism on all thickening tanks consists of a bridle, made of two pieces of channel iron, holding a grooved collar on the end of the vertical shaft. This bridle is supported by lifting jacks that rest on the tank trusses. Two 20x6-ft. Hardinge thickeners are used for thickening table feed and tailing. These tanks are equipped in a similar manner, and deliver a pulp of about 30 per cent solids, with clean overflow.

The distributing drag conveyor, also a flight conveyor, is situated above the feed end of the four Marcy rod mills. It is about 100 ft. long and is provided with adjustable slots at each mill for regulating the feed. Pushbutton starting-and-stopping switches are placed at each feed-regulating slot for the convenience and safety of the operator.

The fine-grinding section consists of four 4x10-ft. Marcy rod mills, each with a 54-in. Akins classifier. The mills are operated at a speed of 23 r.p.m., with a charge of 22,000 lb. of 3-in. steel rods. Mill heads and liners are manganese steel. Discharge of the rod mills, at about 80 per cent solids, passes into the Akins classifiers, where it is diluted to produce the desired size of material in the overflow. The classifiers are operated with a 22-in. weir, which has been found satisfactory for the high-gravity ore treated. The overflow is about 95 per cent minus-100 mesh, in a pulp containing 20 per cent solids. Rake speed is 4½ r.p.m. The classifiers are equipped with hydraulic cylinders supplied with water under high pressure, which permit the lower end of the spiral to be raised quickly out of the pulp while operating, and then lowered again at any desired rate. Pulp densities of the rod mill and classifier overflows are checked every two hours by the operator, by weighing a graduated can and interpolating the per cent of solids from tables. The rod mills are driven by 75-hp. G.E. slip-ring motors through Texrope drives. Classifiers are belt driven from 10-hp. G.E. motors, which also drive a 12-in. screw conveyor for returning the classifier sands to the rod mills. Three rod mills are used to grind 650 tons in 24 hours.

Overflow from the Akins classifiers passes through an open launder, under the floor in front of the Marcy mills, into the decolloiding tanks for the lead section. This unit consists of two 30x6-ft. Hardinge thickeners, one placed above the other. The classifier overflow product passes into the upper tank, where the bulk of the solids is removed by means of two 4-in. Dorrco duplex pumps. Overflow of the upper tank passes into the lower tank, where further solids are also removed by a 4-in. Dorrco duplex pump. The tanks serve to raise the pulp density of the classifier overflow from 20 to 40 per cent solids, at which density it is delivered to the lead flotation section, and controls the colloid content of the pulp. Both tanks are equipped with a raising mechanism of the same type as that used on the 20-ft. tanks, and are driven by 2-hp. motors through Jones speed reducers, the rake speed being 0.25 r.p.m. Thickened pulp from the Dorrco pumps of the upper tank discharges directly into an automatic sampler, together with the pulp from the lower tank. Overflow from the lower tank passes through an automatic sampler, and then through a V-notch wier to the tailing launder.

Flotation cells of the air-lift type, developed at Austinville, Va., and Hanover, N. M., are used in both the lead and zinc sections. These cells are 36 in. wide and 31 ft. 6 in. long, with a depth of 4 ft. 6 in. from the cell bottom to the overflow lip. They are divided into 2-ft. 6-in. sections by cross baffles, which leave spaces underneath to allow free passage of the pulp. Air is delivered at 2.5-lb. pressure through a 6-in. header, 5 ft. above the cell and extending for its full length. Drop pipes, 2 in. in diameter, with regulating valves, extend from the 6-in. header to 3-in. subheaders, from which depend ¾-in. pipes, spaced 6 in. apart and extending 34 in. below the overflow level of the cell. One subheader is provided for each 2-ft. 6-in. section. A ½-in. high-pressure water line is tapped into the 2-in. drop line below the regulating valve, so that the air pipes can be washed out with water if they become choked.

Two sets of baffle boards form the froth chambers. These consist of two inverted V's, open at the top and bottom. The upper baffles, extending to just below the water level in the cell, are spaced wide enough apart at the bottom to allow passage of the agitated pulp between the top of the lower set and the bottom of the upper set of baffles. The top opening of both sets is about 8 in. wide and allows the insertion of the air pipes on the center line of the cell. Tail boards regulate the position of the water level in the cell. A froth column of from 8 to 12 in. is used in the roughers, and one from 12 to 18 in. in the cleaners.

All cells in the lead section are on the same floor level, and set parallel, with walkways between them. Two roughers, 31 ft. 6 in. long, and three cleaners, with a combined length of 31 ft. 6 in., are used with a simple flotation circuit. Tailing from the first rougher is pumped with a 3-in. Krogh pump to the second rougher, the tailing of which passes through a launder to the decolloiding tanks in the zinc section. Concentrate from both roughers is combined with the tailing of the second cleaner and pumped by a 2-in. Krogh pump to the first cleaner. Tailing from the first cleaner is returned to the feed end of the second rougher by a 2-in. Krogh pump, and the concentrate, combined with the tailing from the third cleaner, is pumped by a 2-in. Krogh pump into the second cleaner. The concentrate from the second cleaner is forced by a 1½-in. Krogh pump into the third cleaner. Fresh water is added in the third cleaner for dilution and washing. Concentrate from the third cleaner is the finished lead product. This passes through an automatic sampler, and is delivered by a 1½-in. Krogh pump to a 20-ft. thickening tank in the dryer room.

Reagents added prior to lead flotation consist of caustic soda, soda ash, sodium silicate, hardwood creosote, and fuel oil. A small amount of pine oil is added in the lead roughers for froth regulation.

Tailing from the lead section is delivered through a sloping pipe into the lower of two 30x6-ft. Hardinge thickeners, double-decked to conserve space. Thickened pulp is removed by two sets of 4-in. Dorrco duplex pumps, the tank overflow being elevated to the upper 30-ft. tank by a 4-in. Krogh pump. A single 4-in. Dorrco pump removes the solids from the upper tank. The pulp from the two tanks, at about 40 per cent solids, is combined in a surge box and

Discharge end of waste pipe line and tailing pond at Rex

delivered to the first zinc rougher cell, through an automatic sampler, by a 3-in. Krogh pump.

Flotation cells in the zinc section are the same type and construction as those in the lead section. The section consists of four 31-ft. 6-in. roughers and two sets of three cleaners, each set corresponding in length to one rougher cell. Thickened pulp from the decolloiding tanks is pumped into No. 1 rougher at about 40 per cent solids. Tailing from No. 1 rougher passes through a 3-in. Krogh pump to No. 4 rougher, tailing of which is delivered by a 3-in. Krogh pump to a distributor, where it combines with the tailing from the first cleaners. This feed is divided between No. 2 and No. 3 roughers, the tailings of which pass through an automatic sampler into the tailing line. Concentrate from the four roughers is combined, and then delivered by a 3-in. Krogh pump to a distributor, where it is split between the first two zinc cleaners. First-cleaner concentrate, combined with tailing from the third cleaners, is forced by a 3-in. Krogh pump to the distributor of the second cleaners. Second-cleaner concentrate is delivered by a 2-in. Krogh pump to the distributor of the third cleaners. Tailing of each cleaner is returned to the preceding cell. Concentrate from the third cleaners is finished zinc concentrate, and is pumped to a 20-ft. Hardinge thickener in the drying room for filtering and drying.

Reagents used for zinc flotation consist of copper-sulphate, soda ash, lime, sodium silicate, pine oil, and fuel oil. The conditioning of the zinc is completed by the addition of steam in the first zinc rougher, where the temperature is maintained at from 90 to 100 deg. F. Additions of pine oil and fuel oil are made at the tailing boxes of the first and fourth roughers. A recording pulp-density indicator and a thermometer furnish a record of the pulp in the first rougher, and frequent use of the vanning plaque guides the operator in the regulation of oils. Operators are not permitted to alter the quantities of reagents used, except to change the amount of oil used for froth regulation.

Air for the flotation section of the mill is furnished by two 4-U Type 24 blowers, made by the Allen Air Appliance Company. Each unit, driven at 3,600 r.p.m. by a 125-hp. G.E. squirrel-cage motor through a DeLaval flexible coupling, delivers 6,500 cu.ft. of free air per minute at 2.75-lb. pressure. Both units are operated continuously, and deliver air into a 26-in. pipe, which extends from the blowers to the flotation section of the mill. From this pipe, a 14-in. pipe extends above the cells in the lead section, and an 18-in. pipe, which changes to 14-in., across the zinc section. Headers, 8 in. in diameter, extend above the individual flotation cells for their entire length.

A drift extends eastward for about 200 ft. from the foot of the mill room to the filtering and drying plant, where flotation lead and zinc concentrates are delivered into two 20-ft. Hardinge thickeners. In the zinc section of the dryer, the pulp, at about 50 per cent solids, is pumped from the thickener by two 4-in. Dorrco pumps to a 6x8-ft. Dorrco filter. The cake from the filter, carrying about 9 per cent moisture, drops into a screw conveyor which carries it into the feed end of a 70-in.x55-ft. Christie oil-fired dryer, where the moisture is reduced to about 1 per cent. The dried concentrate drops down an inclined chute, and is elevated to a 10-ton storage bin, from which it is drawn into tram cars. The loaded cars are weighed, hauled by a storage-battery locomotive through the concentrate drift, and dumped into shipping bins along the railroad siding.

The filtrate from the Dorrco filter is removed from the water-separating tank by a 4-in. Dorrco pump and returned to the 20-ft. thickener tank. Overflow of this thickener passes to the zinc section of the flotation plant, part of the water being added to the final concentrate and part entering the last roughers, where slight variations in dilution do not affect results. Another 20-ft. Hardinge thickener receives the lead concentrate, which is pumped to a 6x4-ft. Dorrco filter by a 4-in. Dorrco pump, at about 40 per cent solids. The filter cake is removed from the filter hopper by a short screw conveyor and delivered into tram cars, at about 8 per cent moisture. After being weighed, the cars are hauled to a shipping and storage bin along the railroad siding, where they are dumped. The filtrate from the lead filter is removed from the water-separating tank by a 4-in. Dorrco pump and returned to the 20-ft. thickener of this unit. Overflow of the thickener is returned to the lead section of the flotation plant by a 1½-in. Krogh pump. Part of the overflow is used to move the concentrate to the dryer, and part enters the second lead rougher.

Vacuum is supplied by a 22x8-in. Ingersoll-Rand vacuum pump, driven by a 30-hp. G.E. motor. A 40-in.x35-ft. Christie unit is installed for drying the lead concentrate, but it has not been operated. Seven steel bins are available for concentrate storage along the railroad siding. Six bins are used for zinc concentrate and one bin is used for lead concentrate. These bins, about 9 ft. wide, 15½ ft. deep, and 19 ft. long, are housed with corrugated galvanized steel. Concentrate is removed from the bins through hopper-bottom gates into wheelbarrows for loading into cars.

A concrete pipe line for tailing disposal, with an inside diameter of 18 in., extends from the lower end of the mill room to the tailing pond at Rex, two miles away. It consists of 4-ft. sections laid on a minimum grade of 1½ per cent, and discharges into a distributing box at the head of the tailing pond, which covers an area of about ten acres. The pond is formed by a dam, started by filling between moraine hillocks and built up from coarse tailing drawn off through spigots in the wood-stave distributing pipe line, which runs across the top of the dam for its entire length. Clear water is drawn off through a 3-ft. concrete standpipe, set well back from the dam.

Mill water is obtained from the Eagle River at a pumping plant situated in the canyon, which contains two 2,000-g.p.m. Aldrich centrifugal pumps, driven by 125-hp. G.E. synchronous motors. These pumps can be stopped from several points in the mill, but started only at the pump station control board. Each unit, equipped with vacuum-pump and steam-jet priming devices, discharges into an 18-in. header, which changes to a 12-in. line in the mill room. Only one pump is operated, the mill requirement being about 1,000 g.p.m. The pumps are oiled and inspected each shift, but employment of a pump attendant is not necessary.

Automatic samplers take periodic samples of the mill feed, of all tank overflows going to waste, and of flotation products and tailings. They are operated electrically from a contactor in the upper end of the mill, which controls the individual motors on the samplers and can be timed as desired. Operation of the distributors installed for pulp distribution in the zinc section of the flotation plant is also automatic, and depends on a rotary movement imparted by the passage of pulp through pipe elbows and nipples that extend from a central cone-shaped segment that moves freely.

Ordinary wheel and cutter reagent feeders are used for all oils. Reagents such as soda ash and lime are fed through cup-and-disk feeders, the amount fed being regulated both by cutters placed in the stream and the size or number of cups on the disk. A serviceable pulp-density indicator has been made from a Brown recording water-level indicator by immersing the open end of the air-discharge pipe into the flotation pulp and allowing the air to bubble through slowly.

The chemical laboratory, where all laboratory determinations for the mine and mill are made, is situated in the town of Gilman. Eventually, the laboratory and mill office will be moved to the south end of the mill room. A laboratory for mill control work is already installed on the floor of the zinc section. Included in the equipment are laboratory ball mills, flotation apparatus, drying ovens, Tyler Rotap and screens, as well as a set for hydrogen-ion determinations.

Suitable overhead trolleys and platforms are available at the terminals of the service incline for handling ma-

terial. The incline is equipped with a safety derailing switch at the top, and safety dogs are used on the rear of all cars. The track, which is 24-in. gage, connects with the shop at the lower end of the mill, and serves not only the several benches of the mill but also provides for transporting supplies and tools from the railroad to the shop and other points in the mine.

An Otis passenger and freight elevator, with a capacity of 4,000 lb. and a platform 8x5x8 ft. high, operating in a raise at the north end of the mill room, connects the level of the shop, dryer, and fine crusher with the various floors of the mill. Complete safety equipment, comprising pushbutton controls and automatic stops, top and bottom, are provided. A speed of 100 ft. per minute is used. This elevator has proved to be safe, convenient, and labor saving.

The water main from the river pumping station is a 20-in. cast-iron bell-and-spigot pipe. It is reduced to 16-in. on entering the mill, and is equipped with a Builders Iron Works recording venturi meter. The main water header through the mill, of wrought iron, was cut and flanged at the factory and bolted together in the field. All the other piping was cut and laid in the field. Pipes of 3-in. size and larger are flanged, screwed couplings being used with those of other sizes. Bends in the pulp pipe lines, made of special rubber-lined hose, greatly facilitated erection and have been particularly satisfactory.

Wiring is supported by brackets on steel work and on rock walls. Main circuits are open wiring, but all wires to individual motors are in conduit. Motor controls are placed on standard panels that vary with the size of the motor, but all contain a safety switch, magnetic switch, pushbutton, and test block. Large motors, other than slip-ring units, also have an automatic compensator and pushbutton on the panel. Watt-hour meters are placed on various circuits and individual panels of the larger motors. In all, 28 meters are installed. For the heavier loads and where control of speed is desired 440-volt slip-ring motors are used. The motors driving the two pumps in the river pumping station are 440-volt synchronous units. All the other motors employed are 440-volt, 3-phase, 60-cycle, squirrel-cage machines.

Lighting wires are in conduit. About 400 lamps are used in the various rooms and drifts. Over the jig, tables, and in the flotation section, Cooper-Hewitt mercury-arc lamps are used. Three such lamps are also installed in the machine shop.

A 5-kva., 220-volt, 3-phase, 60-cycle, Kohler automatic generating set, driven by a gasoline engine, was installed for emergency lighting. It supplies, through a special circuit, a smaller number of lights placed in underground rooms comprising part of the concentrating plant and shops. This set is arranged to start up automatically in the event of a power failure on the main circuits. This arrangement affords protection for the men, as they do not carry lamps. The generating set is situated in the Pioneer drift at the south end of the mill room, its exhaust being carried outside through a concrete bulkhead. All electrical wiring and equipment was installed by George B. West, of Denver, Colo., on a cost-plus basis.

Two No. 353 York air-heating units, for operation at 8,500 ft. above sea level, were installed. Each is capable of delivering at least 90,000 B.t.u. per hour, with an intake air temperature of 40 deg. F. These units are installed at the south end of the mill room. They are not used except when the mill is shut down for repairs, as ordinarily the heat generated by the motors, steam lines in the flotation section, and rock heat keep the mill comfortably warm. Ventilation is controlled by eight fireproof doors, installed in pairs in the Newhouse tunnel, loading tunnel, service incline, and the concentrate drift. No difficulty is experienced in ventilating the various rooms and openings, good air prevailing in all of them.

The major units in the boiler plant consist of two 260-hp. Wickes vertical water-tube boilers, using oil as fuel. With the firing equipment, furnished by Wesley Monteith Graff, steam or air may be employed as the atomizing medium. Bailey meters and feed water regulators, with Copes pump governors, comprise the boiler control. The feed water pumps are two Cameron 7x5x13-in. GSS horizontal, simplex, piston units, rated at 68 g.p.m., with water at 190 deg. F. Piston speed is 67 strokes per minute at a water pressure of 200 lb. and with a steam pressure of 150 lb. A 1,100-hp. Cochrane feed water heater, capable of standing 10 lb. per square inch back pressure, is installed. It has ample capacity for heating water at a rate of 33,000 lb. per hour to within 2 to 5 deg. F. of the theoretical temperature, with excess of exhaust steam. The induced draft fan is a Clarage No. 140-S, Type R, steel-plate unit, with water-jacketed double-ring oil bearings. The fan is driven by an 8x8-in. Clarage, Type V, Class 175, vertical engine. It is an enclosed self-oiling unit, developing 56 hp. at 350 r.p.m. engine speed and 570 r.p.m. fan speed. An auxiliary fan, driven by a 75-hp. induction motor at 880 r.p.m., is also available.

The foregoing, together with the first of this series of articles, which was published in the issue of Aug. 10, comprises a general description of the plant and operations of The Empire Zinc Company at Gilman, Colo. Subsequent articles will consider in detail various phases of the enterprise.

Part of Eagle River Canyon and Battle Mountain. Gilman is toward the left, on the mountain slope and along the Ocean-to-Ocean Highway. Below, in the canyon, is Belden, on the Eagle River and the Denver & Rio Grande Western Railroad

Smelting Rich

Lead Products

J. B. Huttl
Assistant Editor

IMPROVEMENTS in flotation practice have helped to diminish the available tonnage of "direct-smelting ores" and of lower-grade products, until several large smelting plants now receive but little of their feed other than as rich concentrate. This is particularly true for lead smelters. Some plants receive only a small amount of their total lead in products containing less than 40 per cent of lead.

In general, gangue constituents of ore may be "dropped" in the flotation cell more cheaply than they can be slagged off in the smelter. Concentrators will continue to make richer concentrate as long as this procedure is economically feasible, and as long as the lead smelters can handle their richer products to advantage. Assuming the ability to handle the richer products, a smelter owning its own concentrator would increase the grade of the concentrate until the loss of lead in the concentrator tailing (caused by returning middling products) would more than counterbalance the saving made by smelting a smaller amount of material and by losing less lead in the smaller amount of slag.

A basis for prediction as to what the smelters operating lead blast furnaces will do in the future as their grade of product increases may be secured by noting what they have already done. A recent study at the Bunker Hill smelter, by the U. S. Bureau of Mines and the metallurgical staff, is particularly timely, for the feed to that smelter contains about 50 per cent lead. Contrary to Australian practice with such material, the rich product is being sintered and smelted, not diluted with slag.

The details of this investigation are given in *Reports of Investigations* 3,088, 3,094, 3,095, and 3,096, by Oldright and Miller, of the Bureau of Mines, all of these articles being published under the heading of "Smelting in the Lead Blast Furnace, Handling Rich Charges." Another report is to follow, on what will appeal to many as the most crucial part of the process—the removal of sulphur from the rich, fusible mixture on the Dwight & Lloyd sintering machines. With similar data already available for the blast-furnace practice at Tooele (U. S. Bureau of Mines, *Reports of Investigations* 2,954, 2,957, 2,963, 2,965, and 2,966), a close comparison can be made of the differences of operation at the various plants as a richer feed is used.

The reports start with the nature of the material received by the smelter, and emphasize the increasing richness of the ores received. Apparently, in the face of the present prices of metals, and requests from the railroads for increase in freight rates, the shipper will probably concentrate his ore to the limit. Small shippers possessing orebodies of insufficient size to justify a concentrator usually have to meet high unit costs of production, and are likely to shut down in times of low prices. The successful operation of the Shattuck Denn mill on lead carbonate ores, and one of International's concentrators at Tooele on an ore that contains other oxidized minerals of lead, indicate that the smelter's supply of unconcentrated oxidized ores is also likely to be severely curtailed. Operators of lead blast furnaces will probably have richer material to handle, and will have to develop a technique to fit this condition.

One of the quickest ways to learn the modifications brought about by a richer lead feed is to study the movement of a rich charge in the blast furnace, as was done in Bureau of Mines *Report of Investigations* 3,094. Among the most radical changes from ordinary practice noted at the Bunker Hill smelter, where the charge contains about 50 per cent of lead is that the height of smelting column is only 7 to 11 ft. The adoption of this short height and the employment of a smaller amount of coke than usual have been found to be two factors most helpful in getting an enormous output of lead bullion from the blast furnaces—more than 200 tons of bullion have been produced in 24 hours. The short height of column would be thought beneficial because of the fusibility of the charge, even before study was made of the gases driven off and of conditions at the tuyère zone.

The rate of subsidence of the charge at any one spot may be fairly uniform during smelting, but sudden drops of several feet may occur, and the rate of descent of different sections may vary considerably. Since the sinter alone is not strong enough mechanically to form bridges, most of these irregularities in the rate of descent of the stock column appear to be connected with the growth of accretions from the walls.

Accretions on the walls of the furnace with the short smelting column are shown by examination to be thickest above the normal level of the top of the charge, and a part of them is due to accumulations of volatilized material. Analyses of the accretions taken from successively lower levels in the blast furnace give the history of formation. The elevations of the accretions that were too cold for smelting, and yet too hot for unaltered charge to exist, consist mainly of sulphides, impregnated with metallic lead.

The accretions in the crucible start from the top and progress downward. At the end of forty days but little free space is present for the molten lead at the bottom of the crucible. The accretions in the crucible also consist chiefly of sulphides, principally zinc sulphide if insufficient copper is in the charge to form matte. A sudden sinking of the charge near the tap hole, owing to the smelting away of an accretion that had been supporting it, is accompanied by the loss of lead. Accretions also cause loss of tonnage in smelting, and limit the length of furnace campaigns. The movement of the charge in a furnace smelting a rich charge is dependent on its fusibility and to the extent to which sulphides were eliminated prior to putting the feed into the blast furnace.

Analysis of gases from the top of a short column of rich charge of the Bunker Hill smelter at Kellogg, when compared with that of similar gases from the International Smelting Company's furnaces at Tooele, shows that distinct differences in the chemical reactions occur in the furnaces of the two plants.

The gases from the top of a lead blast furnace using a higher column and more coke do not differ greatly from gases issuing from the top of an iron blast furnace. They are largely governed by temperature and the $CO_2 + C = 2\ CO$ equilibrium. At Tooele, where a higher column is used, the "top gases" contain about 26 per cent of carbon monoxide and 12 per cent of carbon dioxide, together with a little hydrogen and oxygen. At Kellogg, the corresponding gases are much more variable in composition. They contain only 15 per cent of monoxide as a maximum, usually from 20 to 28 per cent of dioxide, and from a few tenths of 1 per cent of oxygen to about the same amount as in air. The gaseous

atmosphere is then alternately oxidizing and reducing.

With an oxidizing atmosphere, the roasting out of some of the sulphur is possible. The top gases showed, as an average, about 1.5 per cent of sulphur dioxide, or about 80 times as much as in similar gases at Tooele. One experiment indicated that about two-thirds of the sulphur charged to the furnace as various compounds was removed as dioxide in the top gases.

From the standpoint of the gases, the blast furnace with a high column and about 13 per cent of coke in the charge operates much like a gas producer. A furnace with a rich charge, short column, and about 9 per cent of coke operates at times as a blast roaster to oxidize sulphides, and at other times to reduce lead compounds and to liquate metallic lead. The zone of maximum temperature is higher above the tuyères with a furnace that is forced to higher capacity.

A furnace with less coke and a shorter smelting column may be forced to higher capacity, say 20 or 30 per cent more, than one operating with the same feed but using a higher column and more coke. The furnace producing more lead will have a hotter top, more lead in its slag, and will also make three or four times as much dust per blast-furnace day, which dust will contain more volatilized products. The gases from the tops of both types of furnace are diluted about six to seven times before they reach the baghouse.

The concluding study of the U. S. Bureau of Mines on smelting rich charges in the lead blast furnace is made in *Report of Investigations* 3,096, which describes the conditions at the tuyère zone when smelting such a charge in a short column with only about 10 per cent of coke. In many ways the conditions at the tuyère zone give the conditions under which as much as 200 tons of bullion per day can be obtained from a furnace smelting a rich charge.

Maximum capacity was obtained with an irregularly shaped, narrow, elongated area at the tuyère zone that was free for smelting, this free area being only about 25 per cent of the total area at the tuyère zone. The walls of this free area were composed of semi-plastic material, which shifted in an irregular manner as smelting proceeded. Between the walls of semi-plastic material the distance increased at levels higher than the tuyères, to form in elevation a funnel-shaped mass of semi-molten charge. The composition of the material in these walls did not differ greatly from that of the charge.

The air blast, after pentrating these walls of semi-plastic charge, on meeting coke, changed somewhat abruptly to carbon monoxide, chiefly, though at times the air met but little coke and so was only slightly altered. Occasionally, an oxidizing atmosphere, and at other times a reducing atmosphere, obtained at the tuyères. Enough coke was added, so that, although the zone of smelting at the tuyères was narrow, it was of great intensity because of its high maximum temperature. At times the concentration of carbon monoxide was also high—up to 80 per cent. Addition of more coke, or addition of the coke in layers so that it formed an accumulation at the tuyères, gave a more constant monoxide content of the gases there, and reduced the lead compounds more thoroughly, but slowed down the rate of smelting. Coke burns but slowly, and so the addition of more coke than needed to melt the charge lessens the rate of descent of the stock column.

When the furnace was smelting most rapidly, the temperature of the bullion issuing increased, and that of the slag decreased. The lead was apparently melted higher up the shaft. Less of the coke reached the tuyère zone, where sufficient temperature was available to melt the slag, giving less time of contact there.

A state of alternate reduction and oxidation at the tuyère zone permits the furnace to act both as a blast roaster to oxidize sulphides, one of which is lead sulphide, and as a reducer to make metallic lead. The high temperature, and the shape of the smelting zone (narrow at the tuyères and funnel-shaped above), allow the molten lead to liquate out at a rapid rate.

Of the sulphur that reaches the tuyère zone, about half goes into the slag, a third is driven off as gas, and the remainder goes into the bullion. Experiments showed that when the sulphur content of the sinter was high, about two-thirds of the total sulphur fed to the blast furnace was evolved as sulphurous gases.

With sinter of a given quality, beyond a certain rate of charging, the lead content of the slag increased. The maximum rate at which charges may be smelted without the loss of a prohibitive amount of lead in the slag depends largely on the chemical and physical nature of the sinter—the chief ingredient. The sulphur content of the sinter is the most important single variable. With a sinter of high sulphur content, large amounts of coke (and usually scrap iron) are needed to insure a reasonably lead-free slag, which means a slowly running furnace.

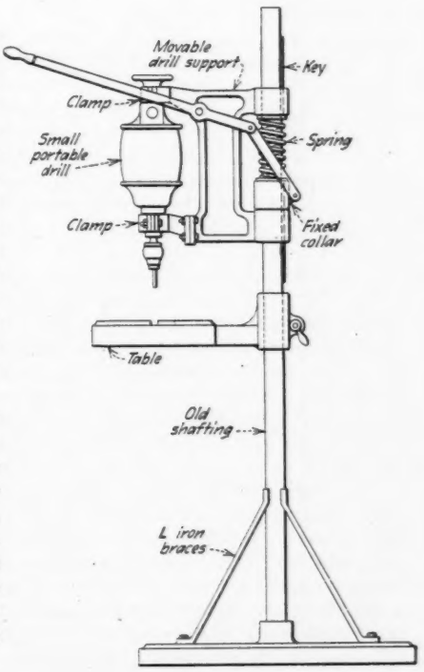
The blast furnace operating with a short column, a small amount of coke, and a rich charge has many points in common with the Scotch hearth. Whether or not changes will be made in blast-furnace practice, together with improvements in preparing the charge, so that the blast furnace will eventually handle as rich a charge as the Scotch hearth, is problematical.

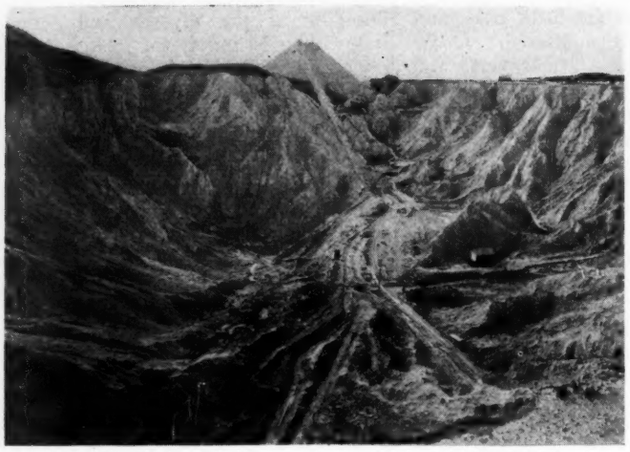
■ ■

Novel Drill Press

LACKING a small drill press in the main repair shop, the mechanical department of Apache Powder Company, at Curtis, Ariz., solved the problem by making from scrap material and with a small, portable electric drill, the neat and light machine shown in the accompanying sketch. The column resting in the pedestal of the cast-iron base is made of 2½-in. steel shafting, and is provided with three welded-on angle-iron braces to lend extra stability. A long key on the upper end of the column serves to guide the movable drill support fitted with two machined clamps to hold the drill.

Additional parts, easily made at any machine shop, are the cast-iron table, a compression spring, and an adjustable collar with the attached lever mechanism. The drill support rests on a spring supported by the fixed collar. This permits the operator to bring the drill slowly down to the object on the table, and counteracts the pressure exerted on the feed lever during the drilling period.





One of the China clay pits in the St. Austell District

CORNISH CHINA CLAY

Ernest H. Davison

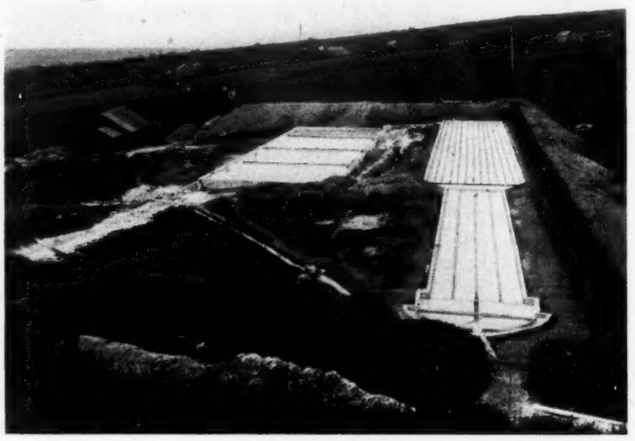
CHINA CLAY has been worked in the West of England for the last hundred years. It is obtained from an altered granite, known as china clay rock, which occurs along the strike of fissure lodes in the granite, found in all the granite outcrops of the West of England, especially in the St. Austell granite area.

China clay rock is the result of the alteration of the feldspar in the granite to kaolin. The change indicated was brought about by magmatic water which rose in the fissure lodes and spread through the surrounding rock. The alteration is therefore most definite near the fissure lodes, becoming more complete as the china clay rock is followed downward. Hard veinstone of the lodes is knows as "stent" to the china clay worker.

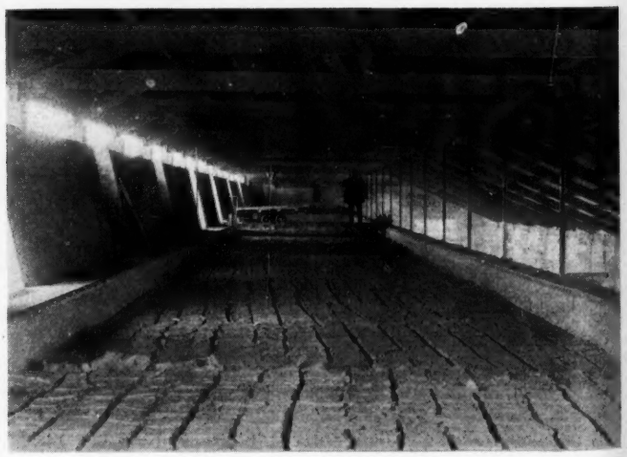
As china clay rock is soft and incoherent, it can be sluiced to clay and sand by a stream of water, which is delivered under pressure through a monitor. The clay-sand stream is directed to large, rectangular, concrete tanks in the bottom of the clay pit, where the sand settles and the clay flows off to a sump, from which it is pumped to the surface. From the bottom of the sand pit the sand is discharged into trams and hoisted to the top of the sand tip. These sand tips, often 150 to 200 ft. high, are characteristic features of the china clay district. The "stent" is elevated to another waste tip, but a certain amount is always left in the pit, because the clay can be more completely extracted from the clay rock by mixing the rock with "stent" fragments.

On reaching the surface the clay is run through the mica drags, consisting of a deep pit followed by long, narrow channels, and then a second pit followed by three times as many channels. The gradient of these channels is so planned that the velocity of the stream gradually decreases as it advances. In the mica drags the fine sand settles first, and then a product composed of coarse clay fragments and mica flakes, which is known as "mica." The fine clay is carried into settling pits, where it settles to a consistency of about 25 per cent clay and 75 per cent water. Modern practice is to build the mica drags and settling pits of concrete.

The clay pit is usually situated some distance from the "mineral" railway that runs through the area, so, to save transport costs, the drying kiln is built alongside the railway and the clay washed to it from the settling pits through a pipe line. On reaching the drying kiln the clay stream is discharged into 60x40x8-ft. concrete tanks, where the clay settles to a consistency of 50 per cent clay and 50 per cent water. It is then trammed to the drying pan—a shallow pan floored with fireclay tiles and heated below by hot-air flues—which runs the whole length of the settling tanks. Here the clay is dried till it contains about 10 per cent water,



Mica drags and settling pits, where mica and sand are removed



China clay in a drying kiln; moisture content about 50 per cent

when it is tipped onto a concrete floor, known as the linhay, below the drying pans, which is alongside the railway.

In the older pits the clay is pumped from the bottom of the pit by Cornish pumps. Modern practice is to pump the clay and sand from the bottom of the pit by means of a gravel pump to high-level sand pits. This reduces tramming costs and makes handling of the sand unnecessary.

Drying of the clay is also partly carried out in filter presses, which greatly reduce drying costs. Paving the drying pan with slates of a basic igneous rock that is quarried in the district results in much quicker drying of the clay, owing to the higher conductivity of the stone slabs; leakage of wet clay into the hot-air flues is also greatly reduced. Attempts to dry the clay by means of steam pipes have not proved successful, and the use of pulverized fuel has been unsatisfactory, as the dust accumulates in the hot-air flues and necessitates constant cleaning.

Exports of China Clay in 1929

Country	Long Tons, 2,240 Lb.	Value, Pounds Sterling
United States	302,410	651,557
Belgium	68,612	130,086
India	32,257	105,496
Germany	41,823	90,129
Netherlands	43,619	94,017
France	46,332	85,536
Italy	24,709	63,609
Sweden	24,772	53,897
Spain	17,180	42,879
Norway	14,659	24,273
Finland	10,064	10,761
Other countries	24,900	63,435
Total	661,675	£1,424,430

China clay is graded into two qualities: (1) bleaching or paper clay, used as a filter for paper cloth, which clay must be of very fine grain and a satisfactory white color; and (2) potting clay, used in the manufacture of porcelain, which must burn white without too much shrinkage. The "mica" is also sold for use in the manufacture of newsprint and paints. Some of the sand is used in the manufacture of concrete blocks.

China clay is exported from England to all quarters of the globe, as shown in the accompanying table, which lists the total quantities exported to various countries in 1929.

Control of the china clay trade was formerly held by an association that fixed prices and regulated production, but this association ceased to function toward the end of last year, and, in consequence, prices of the various grades of clay have declined markedly.

■ ■ ■

Gold-Milling at the Argonaut Mine

GOLD-MILLING practice on the Mother Lode as typified in the plant of the Argonaut Mining Company at Jackson, Amador County, Calif., is described in Information Circular 6467 of the U. S. Bureau of Mines. About 81 per cent of the gold at this mine occurs as coarse and fine metallic particles scattered through large quartz veins and inclosing slates. The remaining 19 per cent is associated with sulphuric minerals.

The method of milling consists in crushing the ore to 2½-in. size by a jaw crusher, followed by crushing in gravity stamps equipped with 24-mesh screens. Amalgamation is practiced both inside and outside the stamp batteries. Tailing from the amalgamating plates is sorted in spitzlutte which produce two spigot products and an overflow. The spigot products are concentrated on vanners, and the overflow pulp, after thickening in a cone, is also treated in vanners.

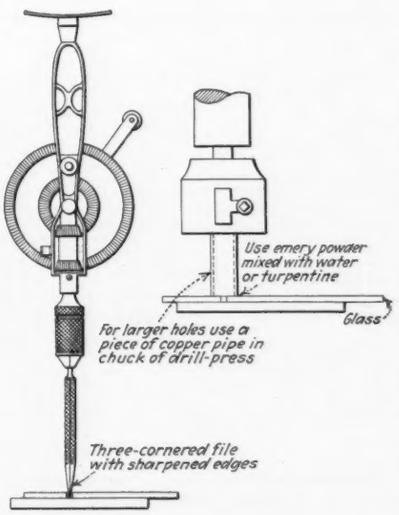
If the tailing from the vanners treating the coarser sand products contains sufficient gold to warrant additional treatment, it is ground in tube mills, after classification and dewatering in a drag classifier. After passing over shaking amalgamating plates the ground pulp is concentrated on tables. Classifier overflow pulp, after thickening, is treated on slime tables.

Concentrate is shipped to the Amador Metals Reduction Company. The general mill tailing is treated under contract in the cyanide plant of the Amador Metals Reduction Company. In 1929, the mill treated an average of 246 tons of ore per day which contained $6.26 of gold per ton. Mill extraction was 89.03 per cent, of which 64.89 per cent was obtained by amalgamation and 24.14 per cent by concentration. Milling cost for this period was $0.96 per ton of ore treated.

■ ■ ■

Reaming Holes in Glass

WITH numerous control instruments in use around mine, mill, and smelter, a broken face dial or some other glass covering, usually equipped with one or more guide holes, often has to be replaced with a home-made piece. Whereas the cutting of the glass into the correct shape, is comparatively simple, the reaming of the holes to the required size may present difficulties if proper tools are not available. Perfect holes can be obtained with the method devised by Charles Labbe, Death Valley Junction, Calif. A triangular file, with a scraper-like end and carefully ground cutting edges, is attached to a breast drill. The glass is then placed on a block of wood, which serves to balance the feed pressure and to guide the reamer point, and the drill spindle is revolved at slow speed until the desired diameter is obtained. Turpentine or water may be used to lubricate the cutting edges. This method is satisfactory for adjusting holes from ⅛ in. to ¾ in. diameter. Larger holes are dressed more accurately with a piece of copper pipe chucked in a drill press, using a mixture of emery powder and water as cutting medium. Both methods are illustrated in the accompanying sketch.


Use emery powder mixed with water or turpentine
Glass
For larger holes use a piece of copper pipe in chuck of drill-press
Three-cornered file with sharpened edges

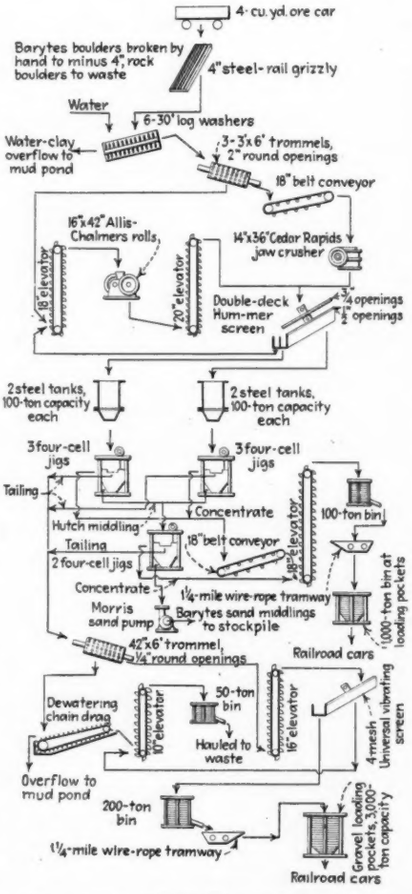
Barytes Producer Enters Washed-Gravel Industry

H. D. Keiser
Assistant Editor

SEVERAL ENTERPRISING operators, as a result of the recent curtailment in outlets for their usual mine products, have developed economically important markets for what formerly have been considered waste materials at their respective properties. Notable among such achievements is that of Thompson, Weinman & Company, operating a barytes property near Cartersville, Ga. In this instance, a washed and sized gravel, obtained as a byproduct in treating barytes ore, is shipped in large quantities to Atlanta, Ga., where it is used as concrete aggregate. Demand for the gravel has increased steadily, making possible the maintenance of operations on a pre-depression scale at the property.

The Paga No. 1 mine of Thompson, Weinman & Company, two miles southeast of Cartersville, Ga., is the major operation on the 700 acres that the company controls in the district. Mining of barytes on the tract was begun in 1916 by the Paga Mining Company, control of the property being acquired by the present operator in 1918. The orebody is classified[1] as a residual deposit of unconsolidated character that overlies and continues down to an unaltered limestone, locally called the Shady limestone. Maximum depth of the deposit is unknown, but it has been mined at the surface and to a depth of 130 ft. Generally, it is covered by soil overburden, which varies up to 12 ft. in thickness. The individual barytes fragments, as they occur in the clayey deposit, range from grains to boulders weighing more than 100 lb. Texture of the exterior or more weathered part is commonly granular, white, and opaque, whereas the interior is crystalline, bluish-white, and translucent. Rounded water-worn quartz and quartzite pebbles abound in the deposit.

The mine consists of several radiating open cuts that average 50 ft. in width and vary in depth from 60 to 130 ft., depending principally on the contour of the surface. Blasting is employed to loosen the ore for loading with steam shovels, which are also used to remove the overburden. The deposit is prospected in advance of mining operations by circular, untimbered test pits, about 4 ft. in diameter and 15 to 50 ft. deep, sunk by hand methods. In loosening ore in the face of an open cut, a pointed steel bar, 1 in. in diameter, to which lengths of pipe of the same size are attached as required, is first driven vertically downward through the ore to the depth of 30 to 40 ft. and at a distance of 6 to 8 ft. from the face. Penetration is effected by pouring water into the hole to soften the clay while the top of the pipe is struck with a sledge hammer. The hole formed is sprung with four to six sticks of 40 per cent gelatine dynamite, fired by cap and fuse. From three to six 50-lb. cans of black powder are then charged into the hole and fired by an electric detonator and a hand blasting machine. About 2,000 tons of ore is loosened per hole. Holes are fired singly. Extent of the ore and leasing requirements determine the ultimate length of each open cut.



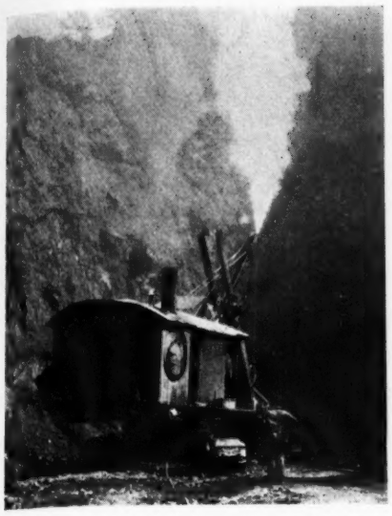
Flowsheet of Paga No. 1 barytes and gravel plant

A No. 32 Marion and a No. 65-B Bucyrus-Erie steam shovel, each equipped with a 1¾-yd. dipper and caterpillar tread, load the broken ore into 4-cu.yd. Western side-dump cars, which are hauled in trains of two cars by 12-ton steam locomotives to the washing plant, about 900 ft. from the open cut. The locomotives are Porter, Vulcan, and Glover units. A 36-in. gage and 50-lb. rail are employed.

At the washer the ore is dumped onto a steel-rail grizzly, with 4-in. openings, where, as shown in the accompanying flowsheet, oversize barytes boulders are broken by hand to pass through the grizzly and the rock boulders sorted out for waste disposal. Undersize of the grizzly drops into six 30-ft. log washers, made by the Davis Machine Works, Rome, Ga. Water is added at the washers, the clayey overflow of which passes by gravity to the mud pond. The washed product is discharged to three 3x6-ft. trommels, with 2-in. round openings. Oversize from the trommels is fed to a 14x36-in. Cedar Rapids jaw crusher. A set of 16x42-in. Allis-Chalmers rolls receives the undersize. Both the crusher and the roll products fall onto a double-deck Hum-mer screen, with ¾-in. openings in the upper screen and ½-in. openings in the lower. Plus ¾-in. material is returned to the rolls; minus ¾-in. plus ½-in. passes to two steel cylindrical tanks, each having a capacity of 100 tons; the minus ½-in. material goes to two other steel cylindrical tanks of the same capacity.

Ore from each of the two pairs of steel tanks is fed to one of two sets of three four-cell Harz-type jigs, arranged in parallel. All the cells of the six jigs are 21x24 in. in cross-section and equipped with 5-mesh Tyler Toncap screen cloth. Concentrate, from side draws, passes to a 100-ton bin at the washer terminal of a 1¼-mile wire-rope tramway, over which the barytes is conveyed to a 1,000-ton bin at the loading pockets alongside a spur of the Nashville, Chattanooga & St. Louis Railroad.

[1] "Report on the Barytes Deposits of Georgia," by J. P. D. Hull; Geological Survey of Georgia, 1920.



Steam shovel in one of the open cuts

Hutch product of the six jigs is fed to two similar four-cell jigs, also in parallel, the concentrate of which likewise passes to the terminal bin. A barytes sand middling from the hutches of the two jigs is delivered by a 2-in. Morris pump to a sand stockpile that adjoins the washer.

Tailing from the eight jigs — the source of the gravel—goes to a 42-in.x 6-ft. trommel, with ¼-in. round openings. Undersize from the trommel, after being dewatered in a chain drag, falls into a 50-ton bin, whence it is hauled a quarter of a mile to waste, in 4-cu.yd. cars, by a 12-ton Porter steam locomotive. The haulage line has a gage of 36 in.; the track is made of 50-lb. rails. Overflow of the drag travels by gravity, with the overflow of the log washers, to the near-by mud settling pond, which covers an area of about 300 acres. Water from the pond returns to the Etowah River, the source of the mill water supply.

Oversize from the trommel passes to a 72-in.x3-ft. 4-mesh Universal vibrating screen that removes the final small amount of sand and water from the gravel. This material joins the sand discharge of the chain drag, with which it is hauled to waste from the 50-ton bin. The clean oversize product of the screen, free from fines, falls into a 200-ton bin alongside the 100-ton barytes bin at the washer terminal of the 1¼-mile wire-rope tramway. At the other terminal the gravel is discharged into a small hopper, through the gate of which it falls onto an 18-in. belt conveyor. Distribution of the gravel from the belt into the 3,000-ton loading pockets below is effected with a rubber plough, which is placed at any desired point along the belt.

The wire-rope tramway carries 80 cars or buckets, each holding about 550 lb. of barytes concentrate or 370 lb. of washed gravel. Barytes is hauled during the 8-hour day shift, and gravel on an 8-hour night shift. The wooden loading pockets, supported on reinforced concrete piers and steel I-beams, are equipped with six steel discharge gates, made by the Webster Manufacturing Company. Open 40-ton railroad cars are used in shipping the gravel to Atlanta, Ga. The barytes, loaded by wheelbarrow, is shipped in closed 40-ton cars to lithopone and other manufacturers in the chemical industries. A grab sample is taken from each wheelbarrow of barytes as it is loaded into a car. Before the car is shipped a representative sample of the combined grab samples is analyzed at the company's laboratory, where analyses are also made of samples taken daily of the products of the washer.

About 250 tons of ore is mined and washed in a 10-hour shift, with a force of 65 men, most of whom are Negroes. The barytes content of the ore averages 5 per cent. Extraction of barytes varies between 94 and 95 per cent. Production of washed gravel is about 200 tons daily. Barytes concentrate ranges up to ¾ in. in diameter. The gravel is plus 4-mesh minus ¾-in. in size.

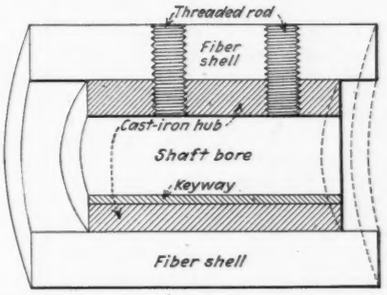
The intake of the water supply of the mill is along the Etowah River, opposite the loading pockets. The pumping units comprise a 6-in. Goulds two-stage centrifugal, with a capacity of 1,300 g.p.m., and a 6-in. Buffalo two-stage centrifugal, with a capacity of 1,000 g.p.m., which is used as a spare unit. These pumps, the wire-rope tramway, and the washing plant are all operated by electric power, obtained from the Georgia Power Company.

To W. J. Weinman, president, Thompson, Weinman & Company, I am indebted for permission to visit the company's operations at Cartersville, Ga., and to prepare the foregoing account. The information contained therein was supplied by H. W. Smith, secretary-treasurer of the company.

■ ■

Repairing Paper Pulleys

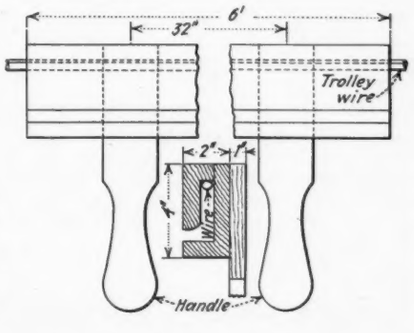
IN the tropics severe climatic conditions often make paper pulleys a source of trouble, writes T. C. Hulton, master mechanic, Cia. Minera Chambas, Abras Grandes, Cuba. These pulleys generally consist of a cast-iron hub and a fiber shell. In time the hub becomes loose and complete destruction of the pulley results if it is not repaired at once. Confronted with this problem, the following method was devised to make a 5x6 in. pulley serviceable: The loose hub was removed, coated with a thin layer of Smooth-On No. 3, and pressed back into place To add extra stability, two holes were drilled and tapped opposite the keyway, to accommodate the ¼-in. threaded rods, as shown in the accompanying sketch. The protruding rods were sawed off and filed below the pulley face, to prevent damage to the belt. A 6x6½-in. pulley was repaired in the same manner, using ⅜-in. rods on account of its larger size.



■ ■

Trolley-Wire Guard

SERIOUS accidents are frequently attributable to inherent defects in the systems used for guarding live trolley wires underground and on the surface, during a track, pipe, or timber repair job. To protect the repair man against this hazzard, the current must either be cut off, causing interruption in haulage operations, or the live wire must be covered with a guard of insulating material at the point where the repairs are performed. A new type of trolley-wire guard has been designed by W. J. McCune, framing-shed foreman at Old Dominion, Globe, Ariz. As shown in the accompanying sketch, it is made of two L-pieces cut from 2x4-in. timber, with a small slot provided on one side to allow insertion of the trolley wire. Two wooden handles, spaced 32 in. from center to center, facilitate handling of the 6-ft. guard.



Personal Notes . . . Comment . . . Criticism

K. S. Twitchell left New York on Sept. 24 for Arabia.

Richard M. Atwater, Jr., for many years associated with Ladenburg Thalmann & Company, has been elected to the presidency of the New York Mining Exchange.

E. B. Holt, formerly connected with mining operations in Sonora, Mexico, is developing a group of gold mines in southwestern Durango, with headquarters in Durango City.

Frank H. Skeels, in charge of the Argentine mining operations of St. Joseph Lead until they were closed down, is now reopening the Boise-Rochester gold mine, at Atlanta, Idaho, for the same company.

C. W. Traughber has been appointed technical and metallurgical adviser to The Northern Blower Company, at Cleveland, Ohio. He was formerly associated with Anaconda Copper, and American Smelting & Refining.

Myron T. Walker, member of the U. S. Tariff Commission, was a recent visitor at several Arizona copper mines. He was collecting data on production costs for inclusion in a report to be submitted to Congress in December.

J. F. Duthie, of Seattle, Wash., was elected president of Jack Waite Mining, at the annual meeting of the company, held recently in Seattle. He has for some time been a large stockholder in the company, and actively connected with the operation of the mine.

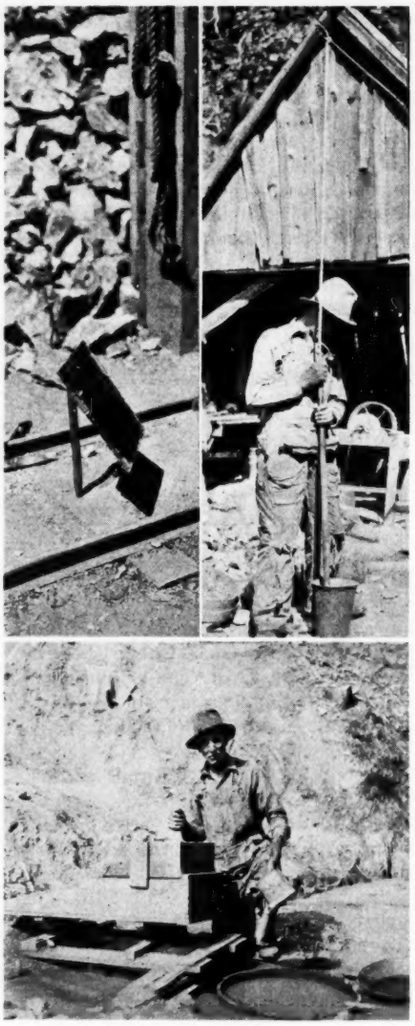
Enoch Perkins writes from Noumea, New Caledonia, that he expects to leave there about Jan. 1, and will eventually reach New York some months later. Chrome mining is being continued where he is, he says, although most of the ore is being stocked.

■

Among contributors to this issue:

Ernest H. Davison, an honor graduate of London University, is head of the department of geology and mining at the Camborne School of Mines. Prospecting and examination work has taken him at various times to Africa, British Columbia, and Nova Scotia, between educational appointments and duties. He is the author of "Handbook of Cornish Geology" and "Blowpipe Analysis."

Dr. Hans Schutt is a graduate of Kiel University. For several years he was industrial chemist at the works of Curtius A.-G., Duisburg, the largest sulphuric acid enterprise in Western Germany. He subsequently became works manager at the plant of Schönebeck Chemical Works A.-G., where he specialized in the production of sulphuric acid from metallurgical waste gases. He is now associated with Mr. Hugo Petersen, the inventor of the process described in this issue and head of the Engineering Bureau for Chemical Industry, with headquarters in Berlin.



Dwight L. Sawyer, whose article "What of Alaska?" in a recent issue will be recalled, sends three interesting photographs of one-man gold mining operations in California. The first illustrates how an ingenious operator has set a mirror at the portal of an adit of the West Forks mine, Plumas County, to illuminate the breast. In the second is shown how gold from the Providence mine in Nevada County is crushed with a pestle suspended from a spring pole, before being treated in the rocker pictured below.

■

Obituary

Jeremiah Rourke, mining engineer, died at his home in Hancock, Mich., recently, after an illness of two years. He was a graduate of the Michigan College of Mining and Technology, class of 1894.

George A. Winslow, veteran Radersburg mining man, died recently at the age of 71. Mr. Winslow's efforts were responsible for the development of a number of mines in the Radersburg district of Montana, through which he accumulated a large fortune. He is survived by his widow.

John Sawbridge, of Yakima, Wash., president of Sunshine Mining, died on Sept. 9 in a hospital in Yakima. Mr. Sawbridge was responsible, more than anyone else, for the remarkable success of Sunshine, which was developed by him and a group of his fellow-townsmen.

W. L. Renner, chief chemist of the American Zinc & Chemical Company at Langeloth, Pa., died suddenly on Sept. 14. He had been in failing health for the last three years. Mr. Renner had been at Langeloth since the early part of 1918. He was a highly competent chemist and one of the most faithful employees of the company for which he worked. His widow and several brothers and sisters survive him.

Albert E. Carlton, mine operator, died at his home in Colorado Springs on Sept. 7. Mr. Carlton had been a resident of Colorado for 10 years, having gone there originally for his health. At the time of his death he was president of Golden Cycle, Cresson Consolidated, and United Gold; and vice-president of Portland Gold. He was 65 years old. Mr. Carlton had also been active in other lines of industrial activity.

Frank R. Corwin, who had a wide circle of friends in the copper smelting and refining industry of the United States, died suddenly of a heart attack in the Bankers'Club, New York, on Sept. 15. His widow, the former Frances Kirwin, survives. His home was at Tennis Place, Forest Hills, New York. Mr. Corwin was born at Union City, Mich., Oct. 6, 1886, and graduated from the engineering school of the University of Michigan in 1908. He then became a testing engineer at Anaconda's Great Falls plant, one year later becoming shift foreman in the roaster department, and afterward being given other duties. In 1912 he resigned to accept a position with the Arizona Copper Company to design a plant for leaching oxidized ores. When this was completed, in eight months, he became shift superintendent at the Copper Queen smelter. Two years later Mr. Corwin was appointed assistant smelter superintendent at the Humboldt smelter of the Consolidated Arizona company, where he remained for seven years and made many improvements, eventually becoming general superintendent. Mr. Corwin came East when the Humboldt plant was closed down, and in February, 1924, accepted a position with U. S. Metals Refining at Carteret, N. J., where he superintended the building of a modern reverberatory furnace. He then went to the Baltimore plant of American Smelting & Refining for a time, and for the last two or three years had been associated in New York with Nichols Copper, of which, at the time of his death, he was vice-president in charge of production at the company's three refineries.

INDUSTRIAL PROGRESS

So-called Dog-leg Device Facilitates Scraping

Other New Equipment Includes Two Light Drill Sharpeners and a Hand-rotated Stoper

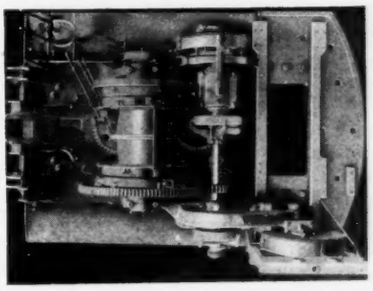
FOR those situations where a drag scraper must turn a corner somewhere along its span and work along two paths at approximately right angles to each other, a patented "dog-leg" device has been developed by Sauerman Bros., 438 S. Clinton St., Chicago. Whereas the usual scraper installation calls for a two-drum hoist winding a pull rope and a tail rope, and two supports for the blocks, the "dog-leg" installation utilizes a three-drum hoist, three ropes, and three guide-block supports. The third block is, of course, at the point where the scraper makes its turn, and the third rope is a so-called "center haul" cable which serves to pull the bucket toward the turning point on both inhaul and backhaul. This third cable passes over the block at the turning point to a rod connecting the front and rear bridles or bails of the scraper, so that it pulls on the front bridle during the inhaul, but slides to the back of the bucket to pull on the rear bridle during the backhaul. The regular load line pulls the loaded scraper from the turning point to the dumping point, and the regular pullback cable, or tail rope, returns the empty bucket from the turning point to the digging point. Such an installation can be applied to advantage where it is necessary to dig or reclaim from storage parallel to track and turn a corner to mount a car-loading incline; in reclaiming from a storage space where columns or other obstructions make it impossible to work radially from the hopper or dump; underground in loading cars in a drift at right angles to the working face; and also in digging lengthwise in trenches on the surface and turning to drag the spoil onto the bank. In the accompanying cut a 1½-yd. scraper is shown reclaiming waste from a pile under a hopper, this involving turning a right angle and dredging the spoil out to a dump parallel with the track.

"Dog-leg" facilitates turning corner in scraping

Controller for Mill Work

For heavy-duty service with series, shunt, or compound-wound d.c. motors, the Westinghouse company has designed a complete line of d.c. magnetic controllers. These are used on cranes or bridges, car dumpers, and in other service where quick and accurate stopping is required. The control panel has an ebony asbestos lumber base supported on a substantial angle-iron framework. Type SM contactors of new design and high rupturing capacity are used. A new thermal overload relay provides inverse time-limit overload protection, the relay tripping also on abnormal overload.

Construction of control benchboards has been improved by the General Electric Company because of their increased application in connection with transfer bridges, conveyor systems, and remote-controlled haulage or larry-car systems. Instead of using special units for each board, mounting schemes have been devised which permit the use of standard controllers, pushbuttons, indicating lamps, and the like. This simplifies maintenance and reduces time needed for getting spare parts. It also permits construction at a lower price.



Mechanism of new ¾-yd. convertible excavator, seen from above

Another Small Excavator

Another convertible excavator introduced by the Bucyrus-Erie Company is the Model 21-B, ¾-yd. machine, which may be used either as shovel, dragline, crane, or clamshell, and which is operated by gasoline, diesel, or electric drive. Among its features are a power dipper-trip which cuts dumping time; oversize clutches and brakes to give easy, accurate control; and power-set hoist clutches. When moving, the machine may be steered from the operator's stand with the cab in any position.

New Motor Starter Safe

A new motor starter introduced by Electric Controller & Manufacturing Company, Cleveland, Ohio, is entirely safe for operation in any adverse atmospheric condition, according to the company. Known as No. 2 Type ZO, it is a self-contained unit, totally inclosed in a heavy 16-gage pressed-steel case having oil-immersed main and control circuit contacts and vapor-proof overload relays. The unit is compact, requiring little mounting space, and is dust-tight.

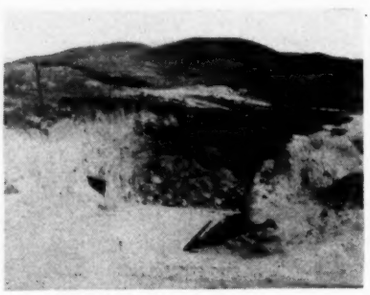
A Light Drill Sharpener

The Gardner-Denver Company, Quincy, Ill., has just introduced a small drill-steel sharpener (Model DS-2), which is intended for the use of contractors, quarrying companies, and others using hand steel. The machine is operated with two die pistons in tandem. Both are used for clamping and upsetting and only one piston is required for fullering and gaging. This design is said to result in unusually low air consumption and longer life. The fullering, clamping, and dollying operations are controlled by a single throttle valve, the lever being placed at the side of the machine for convenience.

This sharpener weighs 1,370 lb. and is designed to handle steel up to 1⅛-in. cross-section and to make bits of a maximum diameter of 2½ in. As regularly equipped, it will make the standard four-point cross bits, six-point bits, and the McLellan-type bits.

Novel Use of Bucket Loader

Mine operators who occasionally may have to do surface grading in connection with laying out a town site or similar tasks may take a tip from the Salt Lake City Commission, which recently has used a bucket loader to open a new street in the outskirts of the city. This involves making a cut in one of the foot hills, as shown in an accompanying cut. At the same time, material for filling in and resurfacing other streets was thus obtained. The ground was first loosened with explosive and then loaded directly into trucks. After being shot, the gravel

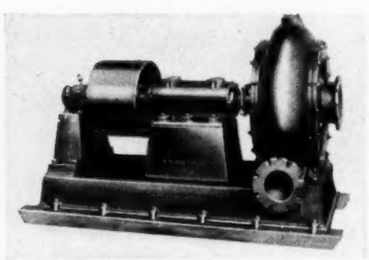


Cut made in hillside with portable bucket loader. See text.

and clay were further broken up by one man with a long steel rod, working directly in front of the helical digging and loading device on the loader. The width of the cut has been as much as 22 ft. and the total yardage thus far removed has exceeded 4,000. In a timed test, the loader handled 7 cu.yd. in 2 min. and 45 sec.

Another Light Sharpener

A drill-sharpening machine for those mine and quarry operators and contractors who have hitherto depended on hand blacksmithing has been developed by the Sullivan Machinery Company, Chicago. This is the so-called Class E sharpener. It will make cross or rose (6-point) bits up to 2½ in. maximum gage on ⅞-in. or 1-in. steel. It forges collar shanks, dies being available for any section of steel. In addition, the sharpener will form and sharpen concrete-breaker pick or chisel bits on hexagon steel as large as 1⅛-in. It weighs only 350 lb. and occupies a floor area only 18 in. square. It stands a little over 4 ft. in over-all height and can be operated satisfactorily without other foundation than is provided by bolting to the floor or light timbers. Its portability permits it to be kept up with the drill and the portable compressor. Moreover, it can be readily disassembled for pack-animal transportation in rough country. The design employs the Sullivan "all-hammer" principle, the upsetting and vertical hammers being worked by compressed air. Steel is held in the clamp for upsetting by a foot lever and toggle, which permit rapid work and afford a secure grip on the steel. Air consumption is said to be low.



New pump of manganese steel for handling abrasives

Reduces Belt Slippage

To eliminate troubles arising from belt slippage and to improve the efficiency of a belt drive, a pulley surface covering, known as "Gripwell," has been developed by the Gripwell Manufacturing Company, 110 W. 34th St., New York City. This is designed to improve the frictional contact between the belt and pulley face and reduce slippage to a minimum. The covering is a canvas treated with a special compound. Applied to a cast-iron, steel or wood pulley, this is said to afford a semi-elastic gripping surface which reduces the slippage. The canvas is cemented to the surface with a cement that contains nothing harmful to the belt. The compound contains both neatsfoot and castor oil, so that the gripping surface of the pulley also acts as a source of supply of these oils to the surface of the belt, lubricating it and prolonging its life. With the pulley thus surfaced, according to the manufacturer, a belt can be run much slacker than is the general practice without use of tightner or idlers. On drives where service is severe, slippage is said to have been reduced to less than one-half of 1 per cent.

For Pumping Abrasive Materials

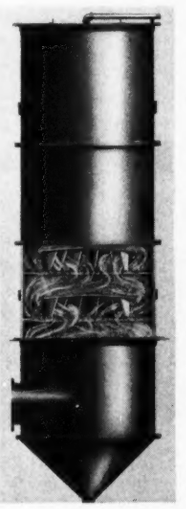
To its line of abrasive-material-handling pumps, the American Manganese Steel Company, Chicago Heights, Ill., has recently added a so-called Type "C" pump, shown in the accompanying illustration. Manganese steel is used in it throughout and several new features have been included. Bearings can be interchanged in the field, both sleeve and anti-friction types being available. Only the main bearings require lubrication, except where outboard bearings are used. The impeller clearance and main bearings can be adjusted readily without dismantling.

Acid Proofing Tanks

The Kobbé Laboratories, Inc., 114 East 32d St., New York, have developed a compound known as Vitrobond, for proofing acid tanks so that they will not require constant lining or other repairs. This material is a sulphur-base compound which is impervious to hot or cold acid, such as sulphuric and hydrochloric. Its tensile strength is many times that of sulphur. It is not affected by heat and has exceptional adhesive properties. It adheres tenaciously to rough surfaces and will form a bond with itself. It solidifies in joints very rapidly, and waste pieces which have solidified after melting can be remelted. The material is supplied in ingots of 10-lb. weight.

A Wet Dust Collector

The cut below shows a new wet-type dust collector introduced by Claude Schneible, 35 East Wacker Drive, Chicago. It is known as the Multi-wash collector. The designer has eliminated moving parts, spray nozzles, pockets, and dead zones. Air and gasses to be cleaned are introduced tangentially at the bottom of the tower, and water or other cleaning or absorbing media at the top, the latter falling in a spray through succeeding plates of the tower, thus giving an intense intimate contact with the upward moving air or gas

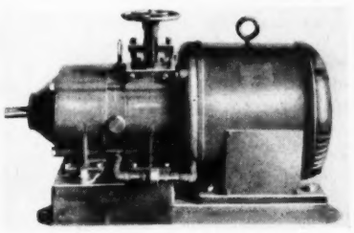


Wet-type dust collector for handling saturated air, hot gases or fumes

which has been compelled to spiral in its course because of vanes with which each plate is provided. Two washes are provided per plate, the standard equipment calling for six plates or twelve washes. This collector, it is said, can handle air saturated with moisture as well as hot gases or fumes, and, according to the manufacturer, the device is particularly adapted for use where dust falling outside of the plant becomes a nuisance or where the material or vapor carried is of value and worth recovering. The collector may be built to suit any condition.

Electro-Hydraulic Transmission Permits Any Speed

One of the cuts shows a small compact 5-hp. electro-hydraulic transmission introduced by the American Engineering Company, of Philadelphia. This transmission will develop full rated torque at any speed, whether it be 1 or 1,000 r.p.m., according to the company. Since the torque is constant, the horsepower output varies with the speed of the hydraulic motor. At maximum



A 5-hp. electro-hydraulic transmission

speed, the transmission will develop 5 hp. continuously.

In the illustration, the hydraulic motor is at the left, the hydraulic pump is next to it in the middle, and the electric motor on the right. These are all mounted on a single bedplate reservoir which contains the oil used in the system. The entire transmission, including motor, is only 30 in. long, 14 in. wide, and 16 in. high. Pump and motor are of Hele-Shaw design and are similar in construction except that the motor has a fixed stroke, whereas that of the pump may be varied from minimum to maximum.

Some New Trolley Hoists

A line of electric trolley hoists, including plain, geared, and motor-driven trolley types, has been completed by the Wright Manufacturing Company, Bridgeport, Conn. The bearings of the trolley wheels are designed to absorb radial and thrust loads, thus facilitating movement of the trolley along the I-beam. The motor-driven units are equipped with a safety stop. Controllers may be had for single speed, two speeds, or variable speed, as desired. The standard lift is 18 ft., but lifts of 9 and 36 ft. can be had. Other features include pushbutton or pendant rope control and weather-proof motors.

A Short-Center Drive for Flat Leather Belts

A new short-center drive which utilizes a flat leather belt under conditions of uniform tension that comprise an ideal set-up for leather belt driving has been introduced by the Chicago Belting Company, Chicago. It is known as the Rockwood drive. As illustrated, it has the motor mounted on a pivoted base in which the weight of the motor is used to keep a prescribed tension in the belt at all speed changes. By using flat leather belts and flat fiber pulleys, a high efficiency is maintained. The drive is said to be most simple and to possess several advantages. The base is used in place of the usual motor rails and is made in six sizes to fit any motor from 1 to 50 hp., 1,800 r.p.m. This drive can be mounted on floor, wall, or ceiling, but cannot drive downward. The development here described is said to bring to short-center driving the full advantages of flat leather-belt transmission, with none of the disadvantages. Once installed, the belt never has to be cut or shortened in any way. The drive is silent and will operate on any short center and with any size of motor.

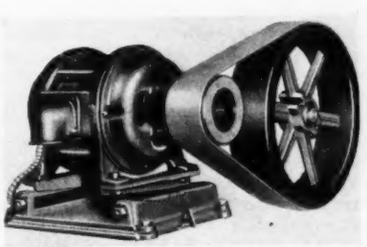
Mammoth Feeder in Nitrate Industry

Two nitrate plants of the Anglo-Chilean Consolidated Nitrate Corporation are equipped with feeders and conveyors provided by the Stephens-Adamson Manufacturing Company, Aurora, Ill. At the Maria Elena plant is a giant feeder which receives the direct impact of entire carloads of rock from a rotary dumper. This feeder is driven by a 100-hp. motor. In its construction, pans 8½ ft. wide and furnished by the American Manganese Steel Company have been used. These interlock to form a slowly moving continuous conveyor surface 41 ft. long. The pans are supported on manganese-steel chains also made by American Manganese Steel. These chains are of 18-in. pitch, each section weighing 2,000 lb. Both pans and chains are designed to allow the conveying surface to bend in only one direction. The other plant referred to is the new Pedro de Valdivia unit, where considerable conveying and feeding equipment has been installed by the same manufacturer.

Stoper's Water Tube Removable Without Disassembling

Gardner-Denver Company has also introduced a new hand-rotated stoper (Model H-81), the hammer of which is of uniform diameter and of reversible block-type construction. The valve is of the tubular automatic type and is located in the back of the cylinder, giving the drill a smooth exterior. Ample bearing surfaces are provided and drilling efficiency is high. The side rods are such that the air-feed cylinder can be removed without disturbing the assembly of the rest of the drill, so that the water tube can be changed quickly.

The feed piston has one cup rubber instead of two cup leathers and the piston head is surrounded by a long brass follower, which can be renewed and serves to prevent the machine whipping on the air feed. Drop forgings and specially selected alloy steel, properly heat-treated, are used in building this drill.



This short-center leather-belt drive has recently been developed. The base is pivoted at A.

Controlling Indoor Lighting

An indoor lighting-control relay (CR7505-D3) designed to turn artificial lights on and off automatically, depending on the light intensity, has been introduced by General Electric. Photo-electric and pliotron tubes are used. The auxiliary equipment includes two potentiometers which can be adjusted from the front of their cases, a sensitive relay, and a normally open contactor with two insulated single-pole interlocks. One of the potentiometers, marked "intensity," is for adjusting the equipment to turn on the artificial illumination at a predetermined intensity of light within the room or building. The other potentiometer, marked "compensating," is for adjusting the equipment to compensate for the additional illumination which will fall on the photo-electric tube when the lights are turned on. If the potentiometers are set at the proper position, when the intensity of the natural light within the room or building decreases to that corresponding to the setting of the intensity potentiometer, the equipment will operate to turn on the artificial light. To turn the lights off, the outside daylight must increase the total illumination in the room to a predetermined point, which is above the light intensity when only artificial light is available.

■

Bulletins

Automatic Control. Mercoid Corp., 4201 Belmont Ave., Chicago, Ill. Catalog No. H-7, Controls for heating equipment and industrial applications.

Excavators. Bucyrus-Erie Co., South Milwaukee, Wis., Bulletin FBE 211, on Model 21B, ¾ yd. convertible shovel. Also Bulletin E421 on Model 42B, 1½ yd. convertible electric shovel, dragline, crane, clamshell.

Blowers. Roots-Connersville-Wilbraham Division of the International-Stacey Corp., Connersville, Ind. Bulletins 22B-10, 23-B-10 covering standard and heavy-duty blowers.

Gaskets. Victor Manufacturing Co., Catalog H, general catalog of gaskets, gasket materials and packings used in the various industries.

Ball Mill. Mine and Smelter Supply Co., Marcy Mill Division, Denver, Colo. Bulletin, Marcy ball mill.

NEWS OF THE INDUSTRY

Copper Mines Cut Wages; Old Dominion to Close

On Sept. 22, the same day that U. S. Steel and several other prominent industrial concerns in the United States announced a reduction in their general wage level, the majority of the large copper mines that had not already done so published the news of a cut in pay scales. In addition, Old Dominion, copper producer at Globe, Ariz., which has not paid a dividend since the days of the World War, has announced that it will close, effective Oct. 1.

The wage cut will amount to 9.1 per cent in the case of all the Arizona copper mines. Miami Copper, which cut its wages in July, is the only important producer that is not taking the step. The cut goes into effect on Oct. 1 and affects workers of Phelps Dodge Corporation at Morenci, Bisbee, and Douglas; of Calumet & Arizona (shortly to be merged with P.D.) at Bisbee, Douglas, and Ajo; of Nevada Consolidated at Ray; of United Verde at Jerome; and of Inspiration Consolidated at Inspiration. Magma Copper is not included in the list received by this publication from Arizona, but this company had put all workers on half pay during the summer months. United Verde Extension is closed down. United Verde and Inspiration had already reduced salaries of officials.

The new rates that will apply will mean daily wages of $4 for shovelers and $4.50 for miners. It is the scale that was in force on May 1, 1921, when the crisis that then obtained in the copper industry forced a widespread shutdown.

In Utah, Utah Copper is cutting wages of all employees 10 per cent. American Smelting & Refining announces that workers at its Garfield smelter, which treats Utah Copper concentrate, will suffer a similar reduction on Oct. 1. Nevada Consolidated is taking the same action at its mines at Ruth, Nev., and Santa Rita, N. M., and at its smelter at McGill, Nev.

The copper mines in Michigan reduced all wages about 10 per cent at the beginning of the current summer. Whether they will make further reductions now that the Western mines are slashing their payrolls is not known.

Closing of Old Dominion means that 450 men at the mine and mill at Globe will be laid off. The O. D. smelter has not been worked for several years, concentrate being shipped to the International Smelting plant for smelting. About 50 men will be retained for pumping, maintenance work, and as watchmen. Although the lowest level of the mine is at a depth of 2,600 ft., water will be allowed to fill to the 2,400. The mine will still supply the town of Globe and the concentrator of Miami Copper with water.

Some broken ore is still being drawn from the O. D. stopes to help pay for salvaging equipment and the expense of closing the mine. Production at this property, equipped to handle 1,600 to 2,000 tons of ore daily, has been running about 600 short tons of copper a month, considerably under capacity. H. I. Barkdoll, general manager of the company, says that the suspension will last until the price of copper rises.

Old Dominion was first worked more than 50 years ago and has been shut down only once—in 1921 and 1922, when the suspension lasted less than a year. One of the oldest copper mines in Arizona, it has for years been handicapped in operation by the necessity of working at increasing depths in ground that is both hot and extremely wet. Recent ore developments had shown extensive bodies of low-grade ore at some distance from the main shaft. Late last year the company acquired the adjoining Arizona Commercial property, to improve ventilation facilities.

■ ■ ■

Report Gold Cord Strike

An important strike of gold ore has been made on the Gold Cord mine, in the Willow Creek mining district, near Anchorage, Alaska, according to Peter Kapovich, who owns a prospect on Reed Creek, in the same district. He states that the company has uncovered a 12-ft. vein which is considered to be the best find in the district in recent years. A small mill was put into operation at this property in 1929. The Lucky Shot mill, at Willow Creek, has been operating steadily, with 80 men employed in the mine and mill.

■

Sylvanite Shaft at 2,600 Ft.

Sylvanite Gold, operating a gold property east of and adjoining Wright Hargreaves at Kirkland Lake, Ont., has carried its new central shaft in the territory north of the east claim of Wright Hargreaves, to a depth of 2,600 ft., with 3,000 ft. as the present objective. When completed, lateral work will be started on eight new levels below 2,000 ft. Current production is at the rate of approximately $80,000 monthly from an ore tonnage of about 260 per day. Sylvanite Gold Mines, Ltd., has a capitalization of $3,300,000 in shares of $1 par, of which 3,299,500 are issued.

■

Hidalgo Mines Protest Capital Tax

A special committee has been appointed by the Mexican Ministry of Finance to investigate complaints made by several mining companies operating in Hidalgo that the state government has levied an 8 per cent tax on invested capitals of mining enterprises. The companies declare the levy is illegal and unconstitutional, as the federal constitution prohibits states, districts, municipalities, or territories from taxing mining enterprises' invested capitals. Principal operators in Hidalgo are Real del Monte, U. S. Smelting subsidiary; Santa Gertrudis, and San Rafael y Anexas, all silver-mining companies in the Pachuca area.

Interest in Gold Prompts Activity at Goldfield

Renewed interest in gold mining, which within the last two years has been the means of stimulating development in so many Western gold camps long dormant, is having its repercussions at Goldfield, Nev., among the most famous of all. Ore has been shipped from a lease on the Goldfield Daisy estate. Pittsburg-Goldfield continues to sink its new shaft. Goldfield Operators, Ltd., is planning a drilling campaign to prospect the Goldfield Consolidated property at depth.

John Stahl and Peter Kretz, who are leasing on the Goldfield Daisy, have shipped a carload of ore said to average $52 a ton. An offer of $50,000 is said to have been made for their lease, but cannot be accepted until approval is obtained from Goldfield Daisy Mining, which owns the property. Controlling interest in this company is held by A. J. Seligman, New York banker, who was reputed to have paid $1,000,000 for it in 1907. Ore faulting and financial conditions resulted in closing the mine soon after.

A. J. Canavan, well-known Nevada mine superintendent, has been put in charge of the drilling that will be undertaken at the Consolidated property, which has produced more gold than any other mine in the camp. The lease obtained by Goldfield Operators covers the entire property, with the exception of three small blocks now being worked by local miners. Henry P. Kervin is president of the leasing company.

At a depth of 760 ft., Pittsburg-Goldfield has encountered moisture in its new three-compartment shaft. Corrin Barns, manager of the company states that the formation is now ledge matter with streaks of quartz, containing a mixture of sulphides and some mineralization resulting from oxidation. The quartz is much shattered and the fragments have become recemented with black quartz and sulphides. The whole is interlaced with seams of amorphous white quartz and pyrite. This is similar to the formation in which many Goldfield orebodies were found.

International Nickel Reduces Output, But Not Wages

Further curtailment of mine and smelter operations of International Nickel at Copper Cliff, Ont., was announced this week. The reductions consisted of closing down one furnace at the Coniston smelter, leaving one in operation; placing the Garson mine on a basis of one shift daily, and reducing the tonnage at Creighton mine by approximately 50 per cent. This leaves the operations of the various Sudbury mines approximately as follows: Frood, 75,000 short tons; Creighton, 15,000 to 17,000 tons; and Garson, about 10,000 tons monthly. An effort is being made to spread the remaining work over as many men as possible, with particular consideration for married employees with families. In all, about 300 men will be affected by the reductions. There has been no disturbance of wage schedules or salaries. Official statement is that none is contemplated.

■

G. G. Rice, on Trial for Tax Evasion, Acts as Lawyer

George Graham Rice, stock promoter, who was taken to New York recently from Atlanta penitentiary, where he was serving a sentence for mail fraud growing out of the sale of Idaho Copper stock, to stand trial for income tax evasion in 1925, not only acted as his own attorney on Sept. 23, in filing motions in federal court, but also wrote his own signature on a show cause order. To be valid this should have been signed by a judge.

The government will attempt to show that in 1925 Rice failed to report an income of $1,800,000. Carlton Fox, Special Assistant Attorney General, also contends, though this is not part of his formal charge, that Rice took in $25,000,000 in the years 1925 to 1928 and that during his long career $100,000,000 had passed through his hands. The show cause order is for the return of ten tons of Rice's records seized by the government, including a so-called "suckers" list of 700,000 names.

■

Patiño May Absorb Araca

A meeting of stockholders of Patiño Mines & Enterprises has been called for Dec. 29 to consider a proposal for absorption of Araca Mining, another Bolivian tin producer. Araca property is in the Province of Loayza, Department of La Paz, and has been producing since 1903. In 1930, it produced mine ore from which 1,175 metric tons of fine tin was recovered, leasers and tailing material contributing an additional 428 tons. Reserves at the end of the year were 208,024 tons, averaging 3.6 per cent tin. Cost of production in 1930 was £138 1s. 9d. per ton, a reduction of £10 from 1929. Patiño, in 1930, produced 17,358 metric tons of fine tin and had reserves of 1,876,473 tons, averaging 4.1 per cent tin. Cost of production was £118 9s. in 1930. The proposed deal calls for the exchange of one share of Araca for one share of Patiño. Araca has 200,000 shares outstanding, compared with 1,380,316 shares of Patiño. Possibilities of developing new orebodies at Araca are stated to be excellent as several veins have not been explored.

■

Crown to Install Dredge

E. G. Lohnes, president of Crown Dredging & Mining, is now on the Pacific Coast negotiating for the purchase of a 5-cu.ft. dredge to install on the company's ground on Birch Creek, 94 miles north of Fairbanks and about 30 miles south of Circle City, Alaska. The company controls a total of 23 miles along the creek. It has been tested by 92 drill holes, showing an average grade of $1.42 per cubic yard of gravel. This average included assays ranging from 30c. along the rim to $6 in the center of the channel.

Present plans call for shipping the dredge early in January by steamer to Seward, whence it will be transported to Fairbanks by rail. From that point to the property, tractors will probably be used to pull the sleds on which the parts will be loaded.

Obituary

Alfred Trewartha James died on Sept. 5 at Johannesburg, Transvaal, South Africa. He was 64 years old. Recognized as an outstanding authority on the cyanide process, which revolutionized gold treatment practice in the 'nineties, he was responsible for its introduction in the Rand and in many other famous districts. He retired from active practice last year, and had gone to the Rand to start suit against various Rand companies in connection with alleged patent infringement. An appreciation of Mr. James' career will appear in an early issue.

Virginia Hope Mill Running

Virginia Hope Mines, Inc., is now running its ten-stamp mill to capacity, getting ore from the Alameda and other claims, about a mile north of Virginia City, Mont. The gold is nearly all free and is recovered on plates and Wilfley tables. A 6,600-ft. transmission line recently was completed to connect with the main line of Montana Power. The mine is opened by a tunnel 857 ft. long. At the face it gives 600 ft. of back. The ore is from 2 to 5 ft. wide. R. R. Peel, of Virginia City, is president and general manager; E. Peel, secretary and treasurer, and C. Stevenson, foreman.

■

Ohio-Keating Mill to Start

Ohio-Keating, operating a gold mine in the Radersburg district, Broadwater County, Mont., has just about completed an 80-ton cyanide plant, which it expects to have in operation about Oct. 15 according to C. L. Hewett, president and general manager.

Seneca Copper Entered in "Friendly" Receivership

Inability to obtain sufficient funds through the sale of stock or otherwise has led to the appointment of F. R. Kennedy and W. F. Hartman as receivers of Seneca Copper, operating properties in the northern section of the Keweenaw peninsula, Michigan. Mr. Kennedy is president, and Mr. Hartman, manager, of the company. They will have charge and manage the property during the period of depression. A suit in equity was brought against the company by the People's Fuel Company, of Calumet, Mich., on behalf of all creditors. Judge F. M. Raymond, of the U. S. District Court, appointed the receivers.

Seneca Copper has been closed since December because of low copper prices. Pumps are still in operation. Estimates place the amount of ore in sight at the time of suspension as 3,500,000 short tons, averaging 1.2 per cent copper. Prior to the shut-down, about 600 tons of ore was being hoisted daily and shipped to a custom milling plant for treatment. Under normal conditions, a much larger tonnage can be produced. Copper output in 1930 was 2,429 tons.

Total indebtedness of the company is $1,680,000 of which $1,482,500 represents outstanding bonds at par value, secured by a first lien on the property and assets. The company's debts for wages, supplies, and other expenses are $95,000. In addition, bond interest due on Jan. 1 and July 1 has not been paid. The receivership is expected to enable continuation of maintenance of the mine and equipment in good condition.

■

Mohawk Suspends Development in Ontonagon County, Mich.

Mohawk Mining has temporarily suspended exploratory work in its Michigan mine property in Ontonagon County, Mich., where "E" shaft was sunk over 800 ft. to an approximate depth of 1,700 ft. From that point a crosscut was driven, cutting the Butler and Evergreen lodes. The Evergreen has been opened by drifting for about 800 ft., in which good ore was found. The proposed mill test is yet to be made, a good-sized stockpile of valuable stamp rock and mass copper having been accumulated. Michigan mine development will be resumed when metal-market conditions improve. Mohawk has sold little metal in the last year, storing its concentrate, unsmelted, until a better price prevails.

■

Assemble Lincoln Gulch Dredge

Seattle mechanics are constructing the shovel dredge of the Lincoln Gulch Placer Mining, near Lincoln, Lewis & Clark County, Mont. The company expects to handle 2,000 cu.yd. per day. This will be passed through a series of trommels and to an Ainslee concentrator. The operating concern is known as Montana Placers, Inc., and is headed by C. I. Wild, of Billings. James LaFountaine, head of Lincoln Gulch, stated that the company controlled a block of ground, 3½ miles long and ¾ mile wide and that the gravel is 52 ft. in depth.

Beatty Says Roan Can Produce Copper Below Present Price

London, Sept. 23.—At a meeting of Rhodesian Selection Trust, held recently, A. Chester Beatty, chairman of the board of directors of the company, said that results in Roan Antelope, in Northern Rhodesia, have proved that the mine can produce copper at a cost below prices now prevailing (about 7c. a pound for electrolytic copper in the New York market, where the Roan product is now being refined). The importance of this statement can hardly be underestimated in view of the fact that Rhodesian copper constitutes at present one of the chief unknown factors in the copper market. Costs have been, above all, a question for debate. Official estimates had previously placed Roan costs at 8c. a pound, exclusive of depreciation, interest, or other charges. A. D. Storke, managing director of Roan, and C. W. Boise, one of the board of directors, are now inspecting the Roan and Mufulira properties, Mufulira being controlled by the allied Canadian Selection interests. Mr. Boise will later go to inspect the diamond workings of Consolidated Diamond Mines and Consolidated African Selection, in West Africa, in which Canadian Selection is also interested.

. . . . Lateral development work at the N'Changa West property of Rhokana Corporation is reported to have disclosed ore of remarkably high grade. However, the water flow has drowned the pumps and is now causing a temporary delay. This N'Changa West area is the ground in which Rhodesian Congo Border Concession had proved 30,000,000 short tons of ore averaging 6.6 per cent copper before the merger which resulted in the formation of Rhokana took place. Later drilling added extensively to the ore area after the estimate was made and the orebody is conceded to be the highest grade yet found in Northern Rhodesia. No delays are reported at the company's N'Kana mine, expected to come into production early in 1932.

■

Indian Copper Raises Output, Cuts Costs, Shows Profit

London, Sept. 23.—Indian Copper, the only producer of refined copper in Asia, is earning a profit despite the low levels to which the price of copper has fallen. In the first half of 1930, the company reports that its mill treated 79,089 short tons of ore averaging 3.285 per cent copper, from which a recovery of 97.25 per cent was made. These figures show a considerable increase over the preceding six months, when 66,823 tons, averaging 3.144 per cent copper, was treated, with recovery averaging 97.19 per cent. Production of refined copper between January and June was 2,105 long tons (2,368 short). Operating costs for all units of copper production were reduced 38.7 per cent. In addition, the rolling mill which the company operates produced 1,581 long tons of yellow metal sheet and reduced operating costs by £2 per long ton. Sales both of refined copper and yellow metal were maintained. Copper in India commands a 25 per cent premium on London prices.

. . . . Tavoy Tin Dredging, operating in Lower Burma, states that its production in the first six months was 330.75 long tons of oxide, which was sold for an average price of £88 a ton. Six dredges and one gravel pump were worked at about 50 per cent of capacity, with recovery averaging 0.5 lb. of tin oxide per cubic yard of gravel treated. Working expenses are 10d. per cubic yard.

. . . . The announcement that Rio Tinto, the largest copper producer in Europe, does not intend to pay any interim dividend for the year to Dec. 31 did not cause much surprise in market circles here. The estimated trading profit for the six months to June 30 last, after allowing for debenture service, is about £250,000. Cash and liquid resources have been severely depleted, particularly owing to the heavy payments to the Spanish government for taxes due on the years 1923-25. Including these and the taxes for the current year to date, the company will have to find £763,991, of which £465,579 has been drawn from taxation suspense account and other advance provisions, and £161,428 has been charged to current revenue. The balance, plus the amount demanded by the Spanish government for the years 1926-30, is to be placed to a suspense account to be liquidated out of the revenue of future years. The company has been adversely affected not only by the unprecedented decline in the price of copper, but also by the falling off in the demand for pyrites, sulphur, and other of its products on the Continent. Moreover, it has large commitments in the Rhokana Corporation.

■ ■ ■

Quincy Suspends Operations for Indefinite Period

Quincy Mining, in the Michigan copper district, suspended operations on Sept. 22 until further notice, pending improvement in the copper metal market. During the last few weeks Quincy has followed a policy of alternate production and suspension, with the hope that the price of copper would increase sufficiently to enable it to continue steady operations. This time no definite date has been set for resumption. In the meantime, the mine will be kept in condition for immediate reopening. Pumps will be operated and necessary timber and repair work given attention. Quincy's new development program has been completed, and the mine is reported ready to produce at a large and steady rate when market conditions improve. In 1930, Quincy produced 5,470 tons of copper.

No one knows how much longer the other mines in the district can continue to operate, even on the present restricted basis. They are working at a considerable loss, primarily to keep as many men as possible employed. Residents of the district have considered it most fortunate that the companies have managed as well as they have under the most trying conditions.

■

Moctezuma Copper Closed

Although some question has arisen as to whether Phelps Dodge would be able to secure permission from the Mexican government to close its Moctezuma Copper property, at Nacozari, Sonora, Mexico, the permission was finally granted and the mine and mill were closed on Sept. 21. More than 1,000 employees were affected. Moctezuma is the second largest copper producer in Mexico and normally mines about 2.000 tons of ore daily. This is treated in the local concentrator and then shipped, as concentrate, to Douglas, Ariz., for smelting at the company's Copper Queen plant. Recovery of copper from concentrate runs between 15,000 and 20,000 tons in normal years. The drop in copper price forced the company to ask for suspension. Definite word was not available until Sept. 15, when P. G. Beckett, general manager of Phelps Dodge, announced that permission had been granted.

■

Safety Men Meet at Chicago

The twentieth annual meeting of the National Safety Council will be held on Oct. 12-16 at Chicago, Ill. An attendance of nearly 7,000, delegates representing the numerous sections of industry that are included in the council is expected. The Congress will have a total of 130 sectionalized sessions—including several covering the mining and metal industries. About 350 speakers are included in the program. The Stevens Hotel will be the headquarters for the meeting. Further information may be obtained from T. A. Burke, director of publicity, National Safety Council, 20 North Wacker Drive, Chicago.

■

Silver Meeting Postponed

The unofficial international conference of silver experts, scheduled to take place in Paris on Sept. 17 or 18, was not held, because of illness of George Roberts, vice-president of the National City Bank, of New York, who was to have been one of the chief representatives of the United States. A dispatch to the New York *Times* on Sept. 18 said that the meeting would probably be postponed to the following week. Norman H. Davis, of Washington, may take Mr. Roberts' place at the conference. The result of the conference will probably take the form of a report to be submitted to the council of the International Chamber of Commerce at its fall meeting, in October. Lord Hunsdon has given notice that he will introduce a motion in the English House of Lords asking a conference with the United States over the problem of stabilizing the price of silver.

Start New Tri-State Mill for Vinegar Hill

Vinegar Hill Zinc, subsidiary of Youngstown Sheet & Tube, with offices in Baxter Springs, Kan., has completed a new mill on the Barr lease in the Kansas section of the Tri-State district and has placed the plant in operation.

A new 52-in. Rogers Foundry chrome steel roll crusher is being tested in the grinding plant. The ore is first sent through a set of 30-in. Rogers crushers and thence to the new rolls, where the ore is crushed to 1-in. size. The mill is equipped with two seven-cell rougher jigs and a cleaner and sand jig. Two Denver-A flotation machines and seven sludge tables are used.

Power for the front end of the mills is furnished by a 150-hp. Bessemer gas engine and a 200-hp. Bessemer provides power for the rear end of the mill. A 165-hp. Bessemer engine propels an 888-cu.ft. Ingersoll-Rand air compressor. In addition the mill has two smaller Chicago pneumatic air compressors. S. H. Davis, of Baxter Springs, is manager of the company's Tri-State holdings.

■

Three Government Drills Cut Potash in New Mexico

Potash is indicated in the analyses of three government test holes, drilled in Lea and Eddy counties, N. M., by the U. S. Bureau of Mines as part of its potash exploration project, according to an announcement made public Sept. 23. Polyhalite, carnallite, and sylvite were found in each core. The three holes completed were Nos. 19, 20, and 23.

Several beds of polyhalite that may have potential commercial value were found, especially in holes Nos. 20 and 23. The principal discovery, however, was a 5-ft. bed of sylvinite (halite and sylvite) at a depth of 691 ft. in No. 23 hole. It contains the equivalent of 30.75 per cent of K_2O and compares favorably with the bed now being mined by United States Potash, or with the high-grade foreign deposits. It is overlain by another 5-ft. bed of halite and sylvite that contains the equivalent of 8.8 per cent of K_2O and could be utilized in mining. No. 23 hole was put down about 14 miles northeast of Carlsbad and 6 miles northwest of the United States Potash property. No. 20 was 35 miles east-southeast of Carlsbad and No. 19 was 70 miles southeast of that town.

■

Mines Near Tucson Reopening

Two properties in the area near Tucson, Ariz., are being reopened by new interests. The old Las Chispas mine, in the Arivaca district, about 65 miles south of Tucson, which was purchased recently by Don Fairchild and T. Childs, of Ajo, Ariz., from E. Holderness, is to be reopened. Work to rehabilitate the old shafts, tunnels and underground workings will be started at once.

According to reports, Philadelphia interests have purchased the Cañada del Oro mine, 26 miles northwest of Tucson, and the Black Canyon placer claims, for the sums of $500,000 and $200,000 respectively. The deals were consummated following reports on the properties submitted by C. W. Steinman, of Tucson. Operations at both properties are to start within sixty days, according to the new owners.

■

Arizona Copper Mines Protest "Excessive" Valuation

Three Arizona mining companies, United Verde and United Verde Extension, of Jerome, and the Copper Queen branch of Phelps Dodge, at Bisbee, paid their 1931 state and county taxes on Sept. 15 under protest. That was the last day for paying taxes under protest in order to bring suit against the state and county to recover. Under the Arizona law a suit against taxes cannot be brought unless the taxes assessed have first been paid under protest. United Verde protested against a valuation of $35,000,000 and Phelps Dodge against a valuation of $27,000,000, on its Bisbee property.

United Verde Extension is making its third protest in three years. If a suit is filed, it will have brought its third suit against excessive taxation. The company claims that the $6,385,940 valuation of its property is about $2,000,000 too high. In the lower court a material reduction was obtained on the 1929 valuation, but the case was appealed to the supreme court by the state tax commission and Yavapai County and is still pending. Last year a second suit was brought, but it is being held in abeyance in the Yavapai County superior court until the previous suit is decided.

■

Students to Work Gold Mine

Mining machinery and equipment for the Eva gold mine, near Ferry, on the Alaska Railroad, have been delivered, according to E. A. Patty, Dean of the Alaska College and School of Mines. Operation of this property will be undertaken by the college with the aim of providing practical instruction for the students and added funds for the institution itself. Active work will start about Oct. 1.

■

Build Mill for Golinsky Area

Construction of a mill with a cyanide unit to treat ore from the Golinsky gossan deposit is now under way at the property, 4 miles from Kennett, Calif. It adjoins the Mammoth copper mine. Lack of funds is said to have hampered development of the gossan deposits in the Golinsky area. They carry both copper and gold. Total area held is 8 claims comprising 165 acres. (Mountain Copper, in Shasta County, in California, has been successfully treating a low-grade copper-gold gossan ore in a mill equipped with a cyanide unit.—Editor.)

Eagle-Picher Co-operates in Tri-State Relief Work

Eagle-Picher Mining & Smelting, subsidiary of Eagle-Picher Lead, has accepted leases on 600 acres of land in the old Galena (Kan.) section of the Tri-State district and has installed a 10-in. Texas pump on the tract. The leases were obtained by a committee of Galena citizens and turned over to Eagle-Picher with the understanding that the mining company dewater the land and sublease it to small prospectors, while the citizens' committee was to raise sufficient money to build flumes and dikes about the caveins and old workings in the section.

Approximately $1,650 has been raised by the citizens' committee in Galena and Joplin to defray the expense of building the flumes and dikes, and the work has been approved by Eagle-Picher, as attested by the installation and operation of the Texas pump. Several hundred unemployed Tri-State miners will probably be given a chance to provide themselves with profitable employment during the winter months.

■

Jack Waite Mining Only in Its Montana Territory

Jack Waite Mining, lead-silver producer with property athwart the Montana-Idaho state line, near Wallace, Idaho, is centering development in its Montana ground which carries what may "justly be termed" a new mine, according to John R. Turner, manager of the company. Practically all operations in the Idaho section have been stopped. The old Jack Waite Extension tunnel, with its portal in Montana, has been connected with the main tunnel by a 460-ft. raise, and a prospect shaft has been sunk to a depth of 200 ft.

In the year ended Aug. 31, 1931, the company mined a total of 68,092 short tons of ore, of which 6,764 tons was rejected in sorting, 3,145 tons was shipped direct to the smelter, and 58,183 tons was put through the company's mill. Smelter payments covered 9,238,059 lb. of lead and 43,885 oz. of silver. Only a small quantity of zinc concentrate has been shipped. Mill capacity is 500 tons of ore daily, but crushing equipment is adequate for 1,000 tons and the remainder of the plant can be brought up to that figure in a short time.

The fractional claim that abutted several of the company claims has been deeded to the company. Placer ground up Eagle and Tributary creeks from the loading site to the mine has been purchased. The Boland property directly opposite the adit has also been acquired.

■

Glidden Operating Barite Deposit

East of Castella, Calif., the Glidden Paint Company is operating a barite deposit and is hauling the mineral by truck to Castella. About 6,000 tons have already been mined, part of which has been shipped to the Bay district. In 1930, California produced 19,783 short tons of barytes.

Pacific Foreign Trade Council Holds Silver Meeting

On Sept. 18, the Pacific Foreign Trade Council, under Arthur G. Prichard as chairman, held a meeting in Oakland, Calif., at which the subject of silver in relation to Oriental trade was discussed. Among the speakers were Senator Key Pittman and Keith J. Middleton. Senator Pittman's address was concerned with foreign trade in relation to the fall in the price of silver. He said that China has no gold but is on a silver standard and has paper money based upon silver. Eighteen months ago the silver price was around 65c. per ounce. Now silver is less than 28c. per ounce. Silver is accepted at par in the internal trade of China. In international trade our exporters fix the price of their products, and in turn receive silver at its intrinsic value, with the result that the Chinese are not buying our goods. The increase in exchange rates is about 4½ times the value of the Chinese dollar, making it impossible to buy foreign goods. The Chinese are compelled to buy at home, and as a result, China is prosperous.

The Senator said that many Chinese business men are gleeful over the barrier raised by the low price of silver, but the national government of China does not share in this attitude for, although taxes are paid to it in silver, its foreign debt must be paid in gold.

The Senator said further: "I am willing to assert that every government in the world except, possibly, two, would be willing to participate in a silver conference." He expressed the opinion that our own government should take the initiative.

Among other interesting statements, K. J. Middleton said: "The general objection to doing anything for silver in America refers back to Bryan and his 16-to-1 scheme. A fundamental difference between that effort and the present situation is that Bryan's proposal was regarded as a national problem. Today it is an international one. The effort of the National Chamber of Commerce, and also of the International Chamber of Commerce, was to effect an international monetary conference of experts who should study the problem and report. So far, no government has appeared willing to take the initiative. . . .

"The International Chamber of Commerce is holding a special meeting in Paris today to consider this question further. No doubt its findings will carry weight, but they will not have the official standing, and therefore will be of less importance than the conclusions of a similar body of representatives duly appointed and accredited by their several governments. It is customary to dismiss the problem of silver on the grounds that it is a commodity and as such must take its course along with all other commodities. But that is only half the truth; silver is a currency for half the population of the world and as such functions quite differently than if it were solely a commodity. In this connection, Messrs. Handy & Harman, in their Review of the Silver Market for 1930, say: 'India and China are vitally important factors in this trade and silver is the measure of wealth among the people of those two great countries. . . . It is inconceivable to us that these 750 million people are ready to change the habit of centuries, and accept the demonetization of silver.'

"A reference has been made to China becoming industrialized. In this connection, the following quotation from private correspondence is interesting: 'There is no doubt that low exchange has done more than high tariffs and cheap labor to enable endless industries to be started up here which must react to the detriment of Western trade.'

"No thinking man could hope or desire to prevent China becoming industrialized, but . . . if nothing is done, if China becomes industrialized as already suggested, and if silver remains at around the present low figure, China will be forced to continue on an even lower standard [of living] than she has known, and her competition will be in terms the Western World cannot hope to meet.

"Alternatively, to raise and stabilize the price of silver will improve her condition, raise her standard of living, and result in a competition more nearly comparable to our own. Is this contemplation not sufficient to cause us to support the effort to bring about an International Monetary Conference?"

■ ■ ■

Tri-State Joins Fight on Rail Rate Increase

Any increase in freight rates will further postpone the day when the lead and zinc mining and smelting industry can be put on a profitable basis, the Tri-State Zinc & Lead Ore Producers' Association and the St. Joseph Lead Company declared in presenting for final argument before the Interstate Commerce Commission last week their evidence in opposition to the railroads' petition for an increase of 15 per cent in rates. The association urged that if any increase is granted, all rates should be treated exactly alike. If no increases are permitted in rates from the Far West, and increases are imposed on rates from the Middle West, the resulting maladjustment, according to the Tri-State organization, will have a decided effect on the flow of traffic and revenues derived by the carriers.

Far Western lead now pays only $3.50 per ton to go from the Western edge (St. Louis) to the Eastern edge (New York) of the consuming area, whereas, to make the same journey, Middle Western lead, said the association, must pay $5 and thereby absorb $1.50 in freight charges. If the $5 rate is increased 15 per cent it will become $5.75 and the necessary absorption will be increased to $2.25 per ton. Obviously, this will still further handicap the sale of Middle Western lead in Eastern markets.

Eagle-Picher Lead represented that it could hardly hope to continue its pigment operations at Joplin if there be any widening of the spreads between the outbound rates on pigments and eastern competitors' inbound rates on pig lead. The company urged that if the commission heeds the plea of Far Western producers for exemption of pig lead from an increase in rates, the rates on pigments should not be disturbed. New Jersey Zinc and its subsidiaries argued that an increase of 15 per cent in rates on ores, concentrates, and other raw materials entering into the manufacture of zinc would result in reducing the carriers' revenues by curtailing traffic. They requested that, in the event of an increase, uniform treatment should be accorded to these commodities throughout the country and that the commission control any subsequent readjustments.

Briefs of Utah Copper and Nevada Consolidated Copper asked that rates be not increased on copper bullion from Utah and Nevada, as large companies are now operating at 40 per cent of normal at a loss and increased freight charges would further curtail the output and might force a complete shutdown. It was stated that over 59 per cent of the employees of metal mines in Utah and Nevada are out of work, and that those retained by the mines are on reduced wages and on a rotating part-time basis. Statement was also made that increased railroad rates would divert copper-bullion shipments to Baltimore via the Panama Canal.

■

White Bear Building Mill

Construction of a 100-ton mill is being undertaken at Chafey (formerly Dun Glen), Nev., by White Bear Mining. Two sets of amalgam plates followed by three Wilfley tables will constitute the simple flow sheet. This property has been under development since 1923 under the direction of George W. Young, manager. A fire in 1927 destroyed a small power plant and mill built by the company. Development has been undertaken through two tunnels. The upper tunnel follows the course of the main vein for 2,500 ft. Twelve oreshoots are reported to have been opened up in this distance, with lengths of from 40 to 100 ft. The lower tunnel, driven at an angle to the main vein, also intersected a blind vein, 25 ft. wide. Drifts driven along the main vein at the point where this tunnel cut it showed 75 ft. of ore. A raise has been put up from the lower tunnel and shows some ore of better than average grade.

■

Homestake Enters Ontario Area

Canadian Homestake Exploration, subsidiary of Homestake Mining, has completed negotiations for an option on the Burgar Prospectors' Syndicate property, one of the oldest known gold prospects in Ontario, on Reserve Island, in the Seince River gold area, north of Sapawe Lake. About 40 years ago the property was prospected by English interests, but in common with other northwestern Ontario prospects was abandoned until about a year ago, when interest was revived. J. A. Noble, Canadian field representative for Homestake, largest gold producer in the United States, will have charge of a program of surface development preliminary to further activity, depending on results.

BRIEF NOTES

Ashley Postpones Mill Plans. Contrary to earlier reports, plans for a mill for Ashley Gold Mining, Mining Corporation subsidiary operating in the Matachewan district, Ontario, will not be formulated this winter. The company has decided to open two more levels in addition to the 125 and 250 levels before a final decision is made. Compressor capacity has been enlarged to speed up the work, and shaft sinking to 500 ft. will be resumed. Development on the first two levels was said to have confirmed drill results.

Big Jim Starts Sinking. Actual sinking of the main shaft at the Big Jim Mines property, Oatman, Ariz., has been started. Work of cleaning out and repairing the shaft at this gold producer has been going on for some time, following the reopening by the original operating company. The shaft will be deepened from its present bottom of 750 ft. to 900 ft., where lateral development will be done for the extension of oreshoots found on the 1,100 level of the Tom Reed mine. Bemis Phelps has been appointed consulting engineer.

Comstock Consolidated Milling. Milling of ore from underground and from dumps at the old California and Ophir mines, in the famous Comstock district, near Virginia City, Nev., has been started by Comstock Consolidated Mines, a Los Angeles concern that is now operating the properties. Underground ore is coming from the Erno shaft in the California, new ore having been developed at a depth of 80 ft. Dumps are said to contain 150,000 short tons of ore. Present rate of treatment is 200 tons daily.

Cusi Mexicana Closes. Announcement has been made to the stockholders of Cusi Mexicana Mining, operating a silver-lead zinc property at Cusihuiriachic, Chihuahua, Mexico, that all work is being suspended. Only pumps will be kept in operation, so as to permit resumption of operations whenever metal markets justify. Recent development of this property had resulted favorably, and production in 1930 was higher than the three preceding years. About 750 men were employed during normal operations, but recently only 300 men have been on the payroll.

East Geduld Early Results. From July 16, when the plant was started, to the end of August, the new mill at the East Geduld property, first new Witwatersrand gold producer in several years, treated 48,700 short tons of ore. At the end of this period, it was handling 1,500 tons daily (compared with rated capacity of 2,000 tons). A partial clean-up recovered 4,196 oz. of gold. This is not a representative result, as much gold is being absorbed into equipment and a considerable amount was still in process. October or November is likely to be the first month of normal operation.

Empire Star Transfer Deed. Final transfer deed of North Star Mines mining claims, in the Grass Valley district, of California, has been placed on record in Nevada City. The claims, which include the Province Mining, Spanish Gold, Wyoming, Utah, Merrifield, and Champion areas, now belong to Empire Star Mines, subsidiary of Newmont Mining.

Falconbridge Puts Down Shaft. Recently a third shaft has been started on the Falconbridge Nickel property, near Sudbury, Ont. It is close to the main shaft and will be used for back-filling. Mine and smelter operations are continuing at the rate of 350 to 400 short tons of ore daily, with the metal output of matte averaging about 250 tons of nickel and 100 tons of copper monthly. Accumulated stocks of nickel are about 1,700 tons.

Golden Center Unwatering. The work of pumping out the old workings at the Golden Center property, at Grass Valley, Calif., has unwatered the shaft to the 800 level. The work will be continued until the 1,100 level is available for resumption of development. More than 6,000 ft. of workings have been driven at this property, and the main shaft is down 1,860 ft.

Granby Cuts Wages. Granby Consolidated, copper producer at Anyox, B. C., has cut wages of all employees 10 per cent because of low prices of metals. The company is not operating its Copper Mountain unit. At Anyox, production has been about normal. Estimates placed the number of men affected at 1,000.

Granite Drifts at 700 Ft. Granite Gold is drifting on the 700 level in the Gold Coin section of its property, Cripple Creek, Colo. The New Market vein is expected to be cut within 150 ft. Ore reserves blocked out are being maintained at more than two years' supply.

Hecla Reduces Working Week. Employees of Hecla Mining, third largest lead producer of the Coeur d'Alene district, Idaho, have been put on a four-day week, compared with a normal of six days and a recent average of five days. The reduction has been made merely to keep output down, as the company has been making a small profit at recent low prices.

Hudson Mining Tax Sale. Hudson Mining & Milling, controlled by the Walker Brothers, of Salt Lake, has redeemed its property at Royston, 35 miles from Tonopah, Nev., at a tax sale. This property shipped some high-grade ore several years ago, and a shaft was put down 300 ft. A. H. Jones, former mill manager at Tonopah Belmont, is attending to redemption of the property.

Luiri May Build Large Mill. Luiri Gold, pioneer gold producer in Northern Rhodesia, is considering construction of a 500-ton mill to treat ore from its Matala Hill deposit. About 2,000 ft. of ore, averaging 6 ft. wide and carrying 7 to 8 dwt. in gold per ton, has been indicated. This ore is too low-grade to treat at a profit in the company's 50-ton cyanide unit, now running exclusively on ore from the Dun Robin mine. In August, production was £4,286 from 1,083 tons of ore, or nearly £4 in gold per ton.

Modoc Acquires Wagner. The Wagner gold prospect, on Coffee Creek, Trinity County, Calif., has been acquired by Modoc Gold Mines. Mine buildings have been erected in preparation for operation. (Whether this company is connected with Modoc Mines, controlled by William Wrigley, Jr., is not known. —Editor.)

Montana Mines Closes Mill. Operation of the flotation plant of Montana Mines at its Spring Hill gold property, near Helena, Mont., has been suspended. The company states that the suspension is only temporary, pending development of a better grade of ore. The average has been less than $5 a ton in gold recently. A deficit of $6,187 was shown on operations for the first seven months of 1931. At the Franklin property, recently acquired, development continues.

Nipissing Stakes at Duparquet. Nipissing Mines, silver producer, of Cobalt, Ont., has staked or has under option an area of 100 claims adjoining the Beattie gold property, which Ventures, Ltd., is developing near Duparquet, Que. The Nipissing holdings extend for a length of 6 miles. Some surface work is being done in the hope of finding extensions of the Beattie low-grade gold deposit.

Rimu Dredge Nearly Ready. Operation of the dredge of Rimu Gold, in New Zealand, will be resumed about Oct. 1, according to the annual report of Kerr Lake Mines, which controls Rimu. Dredging stopped in June to allow the dredge machinery to be transferred to the new steel hull. In the first six months of the year, recovery was 4,946 oz. of gold, or about the same rate as in 1930.

Siscoe Grade High. Production of gold at Siscoe Gold, Dubuisson Township, northwestern Quebec, was about $76,000 in August, an average of $14.65 in gold per ton, compared with $82,500 in July, average $17.45 a ton. The higher July average was due to a clean-up. Development at 600 ft. continues favorable, and extension of mill capacity to 400 tons daily is expected within the next year. This would bring monthly output up to about $170,000.

Talache to Rebuild Mill. Destruction of the mill and surface plant at the Gold Hill & Iowa mine, at Quartzburg, Idaho, by recent forest fires will mean only a temporary interruption in production. Talache Mines, which owns and operates the property, has already replaced some of the mining equipment and will rebuild the surface plant. Reopening of the mine two years ago, followed by development of new ore at depth, had made the property the largest gold-producing mine in Idaho. A new level will be opened at a depth of 1,100 ft. when development is resumed.

Townsend Lead Opens Ezra. Townsend Lead & Zinc has reopened the Ezra R. property, in Arastra Gulch, near Silverton, Colo. Drifting on the main vein, which carries silver and gold, is under way. In addition, the raise from the tunnel to the surface has been put in operating condition, and a winze is being unwatered. Early drifting results show the vein 4 ft. wide.

Trinity Placers Builds Ditch. A 3½-mile ditch is being constructed by Trinity Placers to provide water for the operation of its Bergin claims, near Junction City, Calif.

Decrease in Feldspar Duty Opposed at Hearing

At a hearing before the Tariff Commission on Sept. 17, on an application of the Consolidated Feldspar Corporation for a reduction in the duty of $1 per ton on crude feldspar and of 30 per cent *ad valorem* on ground feldspar, domestic producers countered with an appeal for an increase in the duty. Under the law the commission is restricted to a 50 per cent increase or decrease in the tariff. The position of the domestic industry was indorsed by the American Mining Congress in a brief by its secretary, J. F. Callbreath, and in testimony by A. W. Dickinson and H. M. Payne, of its staff. Mr. Dickinson read telegrams favoring an increased duty from Representative Williamson (Rep. S. D.), the Black Hills Mining and Industrial Association of Rapid City, S. D., and the Community Club of Keystone, S. D. The United Feldspar Corporation, through C. H. Peddrick, Jr., of New York, and the Feldspar Products Company, of Minnesota, also urged an increased duty.

Opposition to any duty on feldspar was expressed by V. V. Kelsey, of Consolidated Feldspar; Bruce Taylor, of Genesee Feldspar, and H. H. Hanna, of the Seaboard Feldspar Corporation. The contention of the advocates of a higher duty on feldspar was that it was designed to meet the competition of Canadian feldspar, the American Mining Congress pointing out that it would permit the employment of 1,100 additional workmen in American mines at an annual wage of $140,000. When statement was made by Mr. Peddrick that Consolidated Feldspar had absorbed the duty during the last half of 1930 by not increasing the price of the Canadian product it handles, H. P. Margerum, of Consolidated Feldspar, admitted that his company had stocked its Rochester mill with a year's supply of Canadian feldspar in advance of the application of the duty under the tariff law of June, 1930.

■

Tri-State Producers' Meeting

A meeting of the board of directors of the Tri-State Zinc and Lead Ore Producers' Association will soon be held, at which time arrangements will be made for the holding of the annual meeting, which, by the bylaws, is supposed to be held on the first Monday in October. The holding of the joint meeting of the Western Division of the American Mining Congress and the regional meeting of the A.I.M.E. on Sept. 28, 29, and 30 may cause the directors to postpone the annual meeting for at least a week.

■

Extend Tunnel in Swisshelms

Chas. B. Flynn and associates are developing a gold-silver property in the Swisshelms, 34 miles east of Bisbee, Ariz. The property consists of 23 patented claims, 8 miles due east of McNeal and 20 miles from the smelter at Douglas. Several parallel veins, carrying gold and silver, have been found. The character of the ore, and the geology, are similar to those of the Tombstone district. In April, work was started on a crosscut tunnel, now over 350 ft. in length. The driving of an additional 300 ft., to cut the first known orebody, will require about three months. New equipment recently installed includes a Sullivan compressor plant. All tunnel work is being done on contract.

■

San Francisco Engineers Visit Grass Valley Mines

Mining engineers and others of the San Francisco section of the A.I.M.E. spent Sept. 12 at Grass Valley, Calif., where the local members of the Institute and several from Nevada joined with them in visiting the mines of the district. The evening meeting was attended by 130. F. W. Bradley, of San Francisco, presided. W. D. Johnston, Jr., of the U. S. Geological Survey, discussed the geology of the Grass Valley district and showed a number of interesting illustrations of ore structure.

James Bradley described the operations at the Spanish mine, now in production. He stated that the mine was idle from 1899 until 1922, when work was started upon a large barite deposit north of the old mine workings. Upon the completion of this work the equipment was moved to Poorman Creek, and the further exploration of the vein, formerly worked by F. W. and P. R. Bradley, was began. Drifting along the course of the vein has disclosed several small oreshoots. These are now being stoped.

A 50-ton flotation mill was completed and placed in operation in April, 1931. It is equipped with a Hardinge ball mill, duplex classifier, and 22 Kraut flotation cells. The ore is complex, and copper, lead, and zinc circuits, consisting of four-cell rougher units followed by two-cell cleaner units, are employed. No conditioning is required in the copper and lead circuits, but the zinc and iron separations are given a preliminary conditioning time of 6 min. in 5x6-ft. conditioning tanks. A variety of reagents is used: thiocarbanilid, zinc sulphate, sodium sulphite, sodium cyanide, amyl xanthate, ethyl xanthate, copper sulphate, lime, pine oil, cresylic acid, and water-gas tar. The final pulp is tabled for the separation of barite. Four separate products are made in addition to the barite product. The ore contains $3 to $6 in gold; 2 to 3 oz. silver per ton; copper, 0.6 per cent; lead, 1.5 per cent; zinc, 2 per cent; iron, 5 per cent, and barite, 20 per cent. Comparatively clean products are made, in all of which gold and silver in varying amount appear.

C. A. Bennett, of the Original Sixteen-to-One mine, entertained the members with a discussion of geologists in relation to gold mining. Errol MacBoyle, of the Idaho-Maryland mine, discussed taxes and industrial accident insurance as factors in increasing mining costs. O. McCraney, of the Murchie mine, described the vein structure of the Murchie and the history of the mine. O. E. Schiffner, of the Hoge mine, after describing its development, stated that the present reserve tonnage is estimated to be 40,625 tons, with a gross value of $1,136,000. F. M. Miller analyzed the gold production of Nevada County and summarized its mining history.

E.&M.J. Will Move to New Home Oct. 10

All executive offices of the McGraw-Hill Publishing Company, and the editorial, business, and advertising departments of *Engineering and Mining Journal*, will be established in the new McGraw-Hill Building, at 330 West 42d St., New York City, on or about Oct. 10. After this date all communications intended for the departments mentioned in the foregoing, and all correspondence with the members of the editorial and advertising staffs, should be addressed to 330 West 42d St.

The new home of the McGraw-Hill Publishing Company has been designed and constructed to insure the ultimate degree of mechanical publication efficiency, and its facilities will, in addition, be made available to the fullest possible extent to subscribers to and advertisers in the technical and business magazines, 26 in number, published by the company. More complete details of the company's plans with respect to these matters will be released in the near future.

The new McGraw-Hill Building will also become the headquarters of the extensive catalog services maintained by the company, and of the McGraw-Hill Book Company and its subsidiary, Whittlesey House.

■

New Carbon and Bort Agency in Chicago

A new agency for the distribution of industrial diamonds has been established in Chicago. Richardson & Hanson, Straus Building, 310 South Michigan Ave., are now sole agents for Gullands' carbon and L. M. Van Moppes & Sons borts in the United States, Canada, and Mexico, as well as constituting the drilling diamond branch of the United States Industrial Diamond Corporation.

The Van Moppes company, of London, formerly mainly interested in wholesale business in America, recently made arrangements through International Diamonds, Ltd., of London, for the distribution of industrial diamonds and borts received by Diamond Corporation, Ltd., a concern lately established to unite the interests of the old Diamond Syndicate with all African diamond-mining companies. J. K. Gulland, Ltd., was established in 1861 by J. K. Gulland, the pioneer in the use of carbon for diamond drilling.

■

Gold Found North of Ketchikan

News has been received at Ketchikan, Alaska, of a strike of gold quartz in the Helm Bay district, 25 miles northwest of the town. William Pritchard and Fred Miller, two prospectors grubstaked by Dr. G. E. Dickerson and R. Nuckolls, of Ketchikan, found the outcrop near the head of Smugglers Cove, south of Helm Bay. Some gold has been produced in this district in the past from the old Gold Standard property, discovered in 1898. Development at depth showed a 40-ft. zone with an indicated average grade for the entire width of $6 in gold a ton, but systematic development or exploitation has not yet been undertaken.

MARKET AND FINANCIAL NEWS

United States Lead Stocks Again Reduced

Statistics on United States production, consumption, and stocks of lead during August were again favorable, more so than was expected. Stocks are now back to where they were at about the end of March of this year, after being 11,000 tons higher at the end of May, and there is every indication that the lead producers have regulated production to consumption without accumulating more than about three months' supply of lead at even the current low rate of consumption, and without being forced to accept the extremely low prices that have characterized the copper market for instance.

The data in the subjoined table, compiled by the American Bureau of Metal Statistics, show a decrease of about 2,000 tons in lead production from domestic ore in August, and an increase of about 1,000 tons in lead from foreign ore. Total production was therefore slightly less than in July but about 1,300 tons higher than in June, which was the low month of the year, following the bottom prices that were registered the month before, and until June 22. The market at that time was 3.60c. in St. Louis, and 3.75c. in New York. The daily rate of production from domestic ores dropped below 1,000 tons for the first time in August.

Shipments dropped about 3,600 tons from those of July, but exceeded any other month of the year, and are most encouraging, indicating that a real increase in consumption has taken place in the last two months. Shipments in September may take another slight drop, perhaps to about 33,000 tons, as only about 29,000 tons had been sold for that month up to Sept. 14.

Stocks of antimonial lead, included in total stocks shown in the table, amounted to 5,366 tons at the end of August. This was approximately half as much as was on hand a year ago last spring. The stocks of antimonial lead have been dropping almost every month since March, 1931, when they amounted to 9,181 tons. Production has recently been a little higher than earlier in the year, being 1,227 tons in May, 1,951 in June, 2,218 in July, and 2,566 in August, but production has not yet caught up to consumption. Demands from battery manufacturers have recently been improving, as the table shows.

Stocks of crude lead amounted to 60,664 tons at the beginning of August, compared with 59,394 on July 1. This was divided as follows: In ore and matte and in process at smelters, 37,471 tons; in base bullion at smelters and refineries, 9,832; in transit to refineries, 2,080; and in process at refineries, 11,281.

Lead ore shipments from the three principal districts in Utah averaged 6,928 tons a week in four weeks of August, compared with 6,315 tons a week in five weeks of July, showing that mining conditions there were unchanged. A few cars of miscellaneous custom ores were received by the Salt Lake valley smelters. Only one furnace, that at the Midvale plant, was running during the month.

United States Lead Statistics

In tons of 2,000 lb.

Production:	July	August
From domestic ore	32,157	30,249
Secondary and foreign	4,409	5,453
Totals	36,566	35,702
Stock at beginning (a)	139,698	133,958
Total supply	176,264	169,660
Stock at end (a)	133,958	131,082
Shipments by difference	42,306	38,578
Shipments reported	42,219	38,590

(a) Domestic origin only.

Industrial classification of domestic lead shipments follows:

	June	July	August
Cable	8,877	10,726	9,250
Ammunition	1,328	2,210	1,795
Tin foil	1,233	1,597	915
Batteries	3,467	4,363	4,617
Brass-making	235	138	166
Sundries	2,677	2,397	2,061
Jobbers	346	378	322
Unclassified (a)	18,891	20,410	19,464
Totals	37,054	42,219	38,590

(a) Of the shipments reported as unclassified about one-third moves normally into white lead and about 30 per cent into red lead and litharge, as averages, but it is impossible to make a monthly segregation of the shipments according to these destinations. Other important manufactures are sheet and pipe, solder, and babbitt metal.

■

U. S. Arsenic Statistics

Arsenic statistics for the United States, compiled by the American Bureau of Metal Statistics, covering the months of May, June, and July, in tons, follow:

	May	June	July
Production:			
Crude	1,491	1,407	1,036
Refined	1,044	1,024	997
Stocks:			
Crude	4,768	4,280	3,972
Refined	2,012	2,201	2,440

Stockholders Approve Merger of Phelps Dodge and C. & A.

Stockholders of the Phelps Dodge Corporation and the Calumet & Arizona Mining Company approved at special meetings held Sept. 21 the plan for the merger of the two companies. Ratification of the merger included the approval of an increase in Phelps Dodge's capital stock to 6,000,000 shares of $25 par value from the present 3,000,000 shares of the same par value and the repeal of a by-law relating to the ownership of stock.

The merger plan provides that Phelps Dodge take over all assets and properties of Calumet & Arizona and issue 3¼ shares of the new Phelps Dodge stock in exchange for each share of Calumet & Arizona. Before the transfer of assets takes place, Calumet & Arizona will declare a cash dividend of $2.50 a share.

At the Calumet & Arizona meeting, which was held in Wilmington, Del., no protests were made against any provision of the merger plan.

■

World Copper Production Shows Little Change

World's production of copper during August was at the rate of 3,940 short tons daily, against 3,919 tons in the preceding month, and 4,992 tons in August of last year, according to the American Bureau of Metal Statistics. Total output for August of this year was 122,155 tons, against 121,504 tons in July.

Production of copper by countries, in short tons, based on copper content of blister, as reported by smelters, without segregation according to countries of origin, for the months of June, July, and August, follows:

World Copper Production

	June	July	August
United States	51,652	46,503	47,246
Mexico	3,867	3,970	4,405
Canada	9,591	9,837	10,586
Chile and Peru	24,785	24,611	23,334
Japan	6,970	7,014	6,619
Australia	1,296	1,271	1,176
Germany	5,161	4,698	5,389
Other Europe (a)	11,800	11,600	11,500
Elsewhere (b)	11,600	12,000	11,900
Totals	126,722	121,504	122,155

(a) Partly estimated. Includes production of blister copper in countries other than Germany, whereof Spain, Russia, and Yugoslavia are the more important. (b) Chiefly Africa.

Copper Producers Protest Freight Rate Rise

Briefs have been filed with the Interstate Commerce Commission by the Utah Copper Company and the Nevada Consolidated Copper Company, protesting the proposed 15 per cent general increase in freight rates. Declaring that "sound economics, public policy, and valid law, all dictate the exemption of copper bullion from Utah and Nevada from any general advance in freight rates," the copper interests urged the commission to make such exemption if it was determined the carriers should have a rate increase.

The unemployment situation in Utah and Nevada is serious and critical, said the brief. More than 59 per cent of the employees in the metal mines in those states have lost their jobs in recent months. Those retained are working at reduced wages and on a rotating part-time basis. The industrial, political, and social leaders of these communities, in cooperation with the federal government, are struggling to meet the challenge and menace of growing unemployment.

An increase at this time would curtail, if not entirely suspend, the production of copper bullion in the states of Utah and Nevada, it is pointed out, with the result that carrier revenues would be reduced and further distress be added to an already grave situation. In any event higher rates would tend to result in a diversion of the entire Utah-Nevada bullion tonnage to the Panama Canal route to Baltimore, Md., thereby reducing rather than increasing carrier revenues.

■

Refined Copper Stocks Up 15,000 Tons in August

Increases in copper stocks during August were about in line with expectations. Refined copper production in North and South America again declined, and both domestic and foreign shipments increased somewhat, but the net increase in stocks amounted to about 15,000 tons. Blister stocks again declined a little, as they have every month recently. Total of blister and refined, in the Americas, in Great Britain, and in Havre, shows a net increase of about 16,000 tons in the amount of copper in producers' hands. The stocks continue to be the largest in history.

Porphyry production has been unchanged for several months. Production from vein mines, from custom ore, and from the Michigan mines was about the same in August as in July, but considerably less than in the preceding months. Low prices are forcing no curtailment in Canada, for the Canadian smelter production in August was the largest since September, 1930. Mexico seems to be doing its bit, too, producing more copper than in any month since January, 1931, when the price was about 10c. a pound.

Summary of Copper Statistics

In tons of 2,000 lb.

Production:	July	August
Mines, United States	38,228	38,925
Blister, North America (a)	60,310	62,237
Blister, South America (a)	24,611	23,334
Refined, No. and So. America	96,408	90,190
World, blister basis	121,260	.....
Stocks (end of month):		
No. and So. America:		
Blister (b)	179,658	176,105
Refined	440,417	455,775
Totals	620,075	631,880
Great Britain (c)		
Refined	21,423	25,157
Other forms	1,243	1,344
Totals	22,666	26,501
Havre	10,252	10,709

(a) Includes direct-cathode copper. (b) Includes in process. (c) Official warehouses only.

U. S. Mine Production

	July	August
Porphyry mines	18,187	18,163
Lake mines	3,692	4,168
Vein mines	15,127	15,294
Custom ores (a)	1,222	1,300
Total crude production	38,228	38,925
Daily rate	1,233	1,256

(a) Partly estimated.

Smelter Production

	July	August
United States	46,503	47,246
Canada	9,837	10,586
Mexico	3,970	4,405
South America	24,611	23,334
Totals	84,921	85,571

Shipments

North and South America

	Export	Domestic	Total
January	30,358	69,932	100,290
February	29,597	61,879	91,476
March	30,523	73,644	104,167
April	29,196	50,017	79,213
May	49,115	75,760	124,875
June	44,818	71,887	116,705
July	42,466	75,436	117,902
August	38,319	56,810	95,129
September	37,873	65,169	103,042
October	38,246	75,703	113,949
November	45,051	62,693	107,744
December	39,169	69,854	109,023
Total	454,731	808,784	1,263,515
1931			
January	45,597	60,209	105,806
February	39,415	60,636	100,051
March	36,797	74,685	111,482
April	32,218	54,567	86,785
May	26,684	45,265	71,949
June	33,251	50,217	83,468
July	26,321	43,144	69,465
August	29,016	45,816	74,832

Compared with the shipments of copper in the period January-August, 1930, the demand for copper in the last eight months shows consumption in the form of wire bars to have been poor. Shipments of ingot bars and cathodes have been running higher than a year ago, both for domestic and foreign consumption. In the foreign market, cakes and bessemer copper were also in better demand in the first eight months of 1931 than for the same period in 1930. Comparing the January-August period for the last four years shows that wire bars formed 63 per cent of the total domestic and foreign shipments in 1928, 62 per cent in 1929, 67 per cent in 1930 and 57 per cent this year. Actual tonnages for the last two years are given in the following statistical compilation of the American Bureau of Metal Statistics:

Forms of Copper Shipped

In tons of 2,000 lb.

	January–August 1930	January–August 1931
Domestic shipments		
Wire bars	344,168	240,445
Ingot bars	12,313	14,742
Ingots	26,489	23,604
Cakes	85,902	78,477
Cathodes	43,923	58,782
Other shapes	22,570	18,489
Total	535,365	434,539
Foreign shipments		
Wire bars	209,611	159,464
Ingot bars	33,788	47,423
Ingots	3,120	387
Cakes	20,375	26,383
Cathodes	9,065	9,542
Bessemer	12,113	20,740
Other shapes	6,320	5,360
Total	294,392	269,299

■

Ontario Refining Reports on First Year of Operations

Ontario Refining, owned jointly by International Nickel, American Metal, Consolidated Mining & Smelting, and Ventures, Ltd., reports a total output of 57,336 tons of refined copper for the first twelve months of operations at its plant at Copper Cliff, Ont. With the exception of about 5,000 tons of blister copper, representing custom offerings from Trail, B. C., and from the Sherritt-Gordon mine, in Manitoba, this output was entirely from Ontario ores, chiefly the Frood mine.

Since the first of the year, when the precious-metals refinery started, the total output of gold, silver, and selenium up to the end of June amounted to 27,764 oz. gold, 1,316,168 oz. silver, and 8,535 lb. selenium. Platinum-group metals from Sudbury nickel-copper ores are now refined in the enlarged plant of International Nickel at Acton, England, production for the six months ended June 30, 1931, being 22,729 oz. platinum, valued at $712,000; 19,352 oz. palladium, valued at $387,040; and 2,907 oz. of other platinum metals, valued at $223,839; giving the precious-metals by-products apart from the gold, silver, and selenium a total value of $1,322,979. The above figures for gold, silver, and selenium cannot be taken as representing six months' production, as they include several months' accumulation of slimes, which were waiting for the construction of the precious-metals refinery.

■

Antimony Ore Imports Up

Imports of antimony ore during the first seven months of 1931 totaled 20,185,785 lb., against 2,428,614 lb. in the same period last year. The antimony content of the ore imported in the January-July period was 6,924,003 lb., against 1,422,634 lb. in the same time last year. The sharp gain in imports for 1931 is due to the completion of the smelter of the Texas Mining & Smelting Company, at Laredo, Tex., early this year.

1930 Barite Output in U. S. Down 15 Per Cent

Crude barite mined and sold or used in the United States in 1930 decreased about 15 per cent in quantity and 17 per cent in value compared with 1929. Total sales of crude barite were 234,932 short tons, valued at $1,538,171, according to a statement by the U. S. Bureau of Mines, based on figures compiled from individual reports by producers. The average value per ton f.o.b. mine was $6.55; in 1929 it was $6.67. Sales of barite were made from eight states—California, Georgia, Missouri, Nevada, South Carolina, Tennessee, Virginia, and Wisconsin; the same as in 1929.

Total sales of barite from Missouri, Nevada, South Carolina, and Virginia showed increases as compared with the record for 1929. Missouri's output (132,640 tons) increased about 12 per cent in quantity and 7 per cent in value over the 1929 figures. The total quantity constituted 56.5 per cent of the total output of the United States in 1930. The output from Nevada increased over three times in quantity and value as compared with 1929, due principally to the increased activity of the American Development Company, Ltd., San Francisco, Calif., which operated the Eagleville mine, in Mineral County. South Carolina's output more than doubled that of 1929, and sales of barite in Virginia showed substantial increases in both quantity and value as compared with the preceding year. The compilations show that sales declined in the remaining states.

Despite the falling off in demand, barite prices were rather well maintained during the first part of 1930, and producers in some cases obtained a higher price per ton than they did in 1929. Market quotations at the end of the year were lower than the levels reached twelve months before, but compared favorably with those for the greater part of the previous year. In Georgia, for example, the quotation for crude barite rose from $6.50 to $9 a long ton late in 1929, but dropped back to $6.50 again late in March, 1930. In Missouri, crude ore started the year at $7.75 to $8 a short ton, and, following the usual seasonal trend, declined to around $6.50 to $7 a ton during the summer months. There is little production during the summer, however, for small producers spend most of their time on their farm work, and prices during this season are more or less nominal. In the autumn, the upward movement of prices was much weaker than usual, and at the close of the year standard grade ore, containing 93 per cent or more barium sulphate and less than 1 per cent iron, was offered at $7 a ton or less, and lower grade barite was down to $6.50 or even $6 a ton.

Washed and water floated barite in Georgia was quoted at $18 a long ton until July, when quotations ceased.

The apparent stocks of domestic crude barite held at mines at the end of December, 1930, were 45,255 short tons, 37,852 tons of which were held in Missouri, 1,568 in Georgia, 5,057 in Nevada, and the remainder in the other producing states. The term "stocks" as used by the U. S. Bureau of Mines includes only those stocks held at mine or shipping point, which have not entered the market. Considerable stocks of crude barite are held by the grinders and chemical companies, but as the barite held by these companies has already left the mines, it is included in the statement of marketed production of barite.

The total quantity and value of crude barite imported for consumption in the United States in 1930 was 52,111 short tons, valued at $179,579. As compared with the 1929 record, the figures show a decrease in quantity of 33,618 tons or 39.2 per cent, and of $104,857, or 36.9 per cent, in value.

Consumption of crude barite (both foreign and domestic) in the United States in 1930, as reported by the manufacturers of barium products and chemicals, was 334,139 short tons, as compared with 334,406 tons in 1929. Of this quantity (334,139 tons) 53.6 per cent was used in lithopone, 20.7 per cent in ground barite, and 25.7 per cent in barium chemicals.

■

U. S. Quicksilver Imports

During July 11,409 lb. of quicksilver was imported into the United States, against 2,432 lb. in July, 1930, according to the Bureau of Foreign and Domestic Commerce. Imports for the first seven months of the current year totaled 27,054 lb., against 147,295 lb. in the same period last year.

Crude Barite Sold by Producers in the United States, 1929-30

State	1929 Short Tons	1929 Value Total	1929 Value Per Ton	1930 Short Tons	1930 Value Total	1930 Value Per Ton
California	24,701	$147,762	$5.98	19,517	$114,310	$5.86
Georgia	94,118	546,212	5.80	41,746	230,769	5.53
Missouri	118,679	880,319	7.42	132,640	938,812	7.08
Nevada	818	6,384	7.80	2,647	19,457	7.35
Tennessee	26,140	181,725	6.95	17,006	111,981	6.58
Virginia	(a)	(a)	(a)	10,250	73,168	7.15
Other States (b)	12,813	88,304	....	11,126	49,674	....
	277,269	1,850,706	$6.67	234,932	1,538,171	$6.55

(a) Bureau of Mines not at liberty to publish.
(b) 1929: South Carolina, Virginia and Wisconsin; 1930: South Carolina and Wisconsin.

Canadian Asbestos Industry Advances in 1930

Manufacture of asbestos products in Canada reached a new high level during 1930, when the output was valued at $2,301,924, according to the Dominion Bureau of Statistics. This value was slightly higher than for 1929, and marked the seventh successive year in which the industry has made an advance.

Eleven Canadian plants are engaged in this manufacture, four of which, in the province of Quebec, the center of the asbestos mining industry, accounted for 79 per cent of the production. Ontario also has four factories, British Columbia two, and Nova Scotia one. Total capital employed by these concerns is $2,316,345; 306 men were employed, drawing a total of $401,490 in salaries and wages; materials for manufacturing cost $1,327,025 at the works.

Products from these plants included asbestos brake linings, boiler and pipe covering, packings, shingles, lumber, paper, clutch facings, blackboards, and tile. The following is a list of the operating firms: Guildfords Limited, Halifax, N. S.; Asbestos Corporation, Ltd., St. Lambert, Montreal, Que.; Asbestos Manufacturing Company, Ltd., Lachine, Que.; Atlas Asbestos Company, Ltd., Montreal, Que.; Canadian Johns-Manville Company, Ltd., Asbestos, Que.; Asbestos Covering Supply Company, Toronto, Ont.; Canadian Raybestos Company, Ltd., Peterborough, Ont.; Garlock Packing Company, Hamilton, Ont.; A. C. Wild & Company, Toronto, Ont.; H. Baille & Company, Vancouver, B. C.; and Spicer's Asbestos, Ltd., Vancouver, B. C.

■

Quicksilver Production Much Less in 1930

Data on world quicksilver production are given in the year book of the Metallgesellschaft, just issued. Production in 1930 was only about two-thirds of that in 1929, though American production increased and amounted to about a quarter of world production for the first time in years. No data on stocks are given, but estimates have recently been made that current stocks are at least 200,000 flasks, equivalent to 6,900 metric tons; or well over a year's supply even when industrial consumption is good. Production for 1929 and 1930, in metric tons, is given in the accompanying table.

World Quicksilver Production
(In Metric Tons)

	1929	1930
Spain	2,476	636
Italy	1,998	1,925
Czechoslovakia	65	60
Russia	120	120
Austria	5	2
Other Europe	5	6
Africa	4	11
United States	816	743
Mexico	83	166
Total	5,572	3,669

Phelps Dodge Reports Loss in First Six Months

Phelps Dodge and subsidiaries report for six months ended June 30, estimates consolidated net loss of $367,400 after taxes, charges and depreciation, but before depletion. For the six months ended June 30, 1930, the company reported a net profit before depletion, of $1,082,707, equal to 54c. a share (par $25) on 2,000,000 shares of stock.

Estimated consolidated income account for the six months ended June 30, 1931, follows: Proceeds from sale of metals, manufactured products, coal and merchandise, and from treatment tolls, $24,389,189; costs, expenses, taxes, and other charges, $23,546,123; balance $843,066; other income, $324,203; total income, $1,167,269; depreciation, $1,534,669; consolidated net loss before depletion, $367,400; dividends declared, $2,117,042; deficit, $2,484,442.

■

Domestic Feldspar Producers Oppose Cut in Tariff

The present tariff rates on feldspar were declared by the importers of that product to be "only a burden on the consumers" in this country, during a hearing before the Tariff Commission held in Washington, D. C., Sept. 17. The hearing was a part of the commission's investigation of the tariff rates on feldspar brought about as a result of the application of the Consolidated Feldspar Corporation, of Trenton, N. J., for a 50 per cent decrease in the present rates on the product.

C. H. Peddrick, representing the United Feldspar Corporation, submitted letters to the Tariff Commission which, he stated, were from the majority of feldspar grinders in the United States, representing an investment of over $4,000,000, none of whom sanctioned a decrease and most of whom were in favor of an increase in the present rates. The domestic producers, he told the commission, oppose any decrease in the present duty because they "see no reason for imports of the Canadian product." Mr. Peddrick predicted that "feldspar will be brought into the United States at ridiculously low prices in the future because large companies are being organized in Canada to extract radium from deposits which are largely composed of feldspar."

Herbert P. Margerum, of the Consolidated Feldspar Corporation, in answer to Mr. Peddrick, who said his company had evidently absorbed the increase in tariff over 1922, as it had not increased its prices during the first six months of this year, asserted that the Consolidated company had brought in a year's supply of the crude product in anticipation of the new tariff law.

Victor B. Kelsey, New York, representing the Consolidated Feldspar Corporation, said his firm not only mines the crude product in this country, but also imports the crude from Canada and mills it at Rochester, N. Y. He asserted that since 1923 imports of the Canadian product have been gradually decreasing, while production and consumption of domestic feldspar have increased. The Canadian product, he told the commission, sells from $3 to $4 per ton higher than the American product, because of higher production costs and freight charges on foreign spar.

During the hearing it was brought out and agreed to by both sides that the Canadian competition is the only competition domestic millers in the United States meet, although the product is produced by various European countries.

World Silver Production

Data on silver production from countries that last year turned out about 87 per cent of the world's supply, compiled by the American Bureau of Metal Statistics, in thousands of fine ounces, follow:

Country	Monthly Average 1931	July, 1931	August 1931
United States	2,857	2,176	2,459
Canada	1,573	2,133	1,610
Mexico	7,506	6,390	.....
Peru	1,079	1,063	795
Australia	636	633	537
Burma	504	460	460
Total	14,267	12,855	.....

Stocks in the United States at the end of August amounted to 2,240,000 oz., compared with 2,077,000 at the end of July, and 1,611,000 oz. at the end of June.

Moderate Increase in Demand for Metals—Copper Makes New Low—Silver Up

New York, Sept. 24, 1931.—Though uncertainty over the probable effects of England's suspension of free gold payments unsettled world trade in commodities, the domestic demand for non-ferrous metals increased moderately, particularly in the second week of the fortnight under review. The increased buying interest resulted largely from realization on the part of some consumers that prices are exceptionally low. Copper sold down to 7c. per pound, delivered, a new low for the movement. Silver was strong in anticipation that the metal is destined to come to the fore because of the developments in the gold situation. Tin fell sharply on the drop in sterling exchange. Little change occurred in lead and zinc. In the minor metals, lower prices were named for bismuth and quicksilver.

Copper at 7c.

The trend of prices again was downward, owing chiefly to the disappointment over the general state of business and the steady accumulation in supplies of copper. Stocks of refined copper at the end of August amounted to 455,775 tons, the largest in history. Demand for copper at 7.50c., delivered Connecticut, almost dried up, and prices were lowered gradually by custom smelters to attract new business. On Sept. 16 the metal sold down to 7c., establishing a new all-time low. There were sellers of copper at 7c. throughout the last week for delivery over the first quarter of 1932, and a little business was booked even beyond March shipment. Demand for early 1932 metal was fair at 7c.

In copper circles it is understood that producers will come together in two or three weeks to review the developments of the last year and attempt to bring out some degree of order in the copper industry.

Two properties were shut down in the last two weeks—Moctezuma and Old Dominion. Magma Copper has reopened its mine preparatory to starting its smelter on Oct. 1. Arizona copper mines lowered the wage rate by about 9 per cent.

Export business in copper remained quiet, sales so far this month amounting to a little more than 12,000 long tons. Copper Exporters, Inc., reduced its price to 7.75c., c.i.f. on Sept. 10, and to 7.50c. on Sept. 16.

Zinc Lower

Demand for galvanized products showed little or no improvement, which was reflected in a slow demand for zinc during the last two weeks. A little selling pressure developed in some directions, but not enough to bring out any real weakness in the market. Scattered lots sold down to 3.70c., St. Louis, during the last week, a net reduction of 10 points from the selling basis established two weeks ago. Production is being held in check, and most of the metal held by producers appears to be in strong hands.

Lead Sales Improve

Demand for lead improved somewhat toward the close of the period, and prices showed little change, despite the unsettlement in other major metals. Leading producers continued to hold out for 4.40c., New York, the A. S. & R. contract level, and 4.225c. St. Louis. The St. Louis price, however, showed some irregularity toward the close, as one operator sold desilverized lead on the basis of 4.10c. and 4.15c. in that territory. Indications are that shipments of virgin lead in September will not be more than 32,000 to 33,000 tons, and therefore less than in any of the last three months, but producers are not at all alarmed and feel that the

statistical position of lead is unlikely to take an unfavorable turn.

Tin Price Falls

The break in sterling exchange naturally exerted a profound influence in the market for tin, and prices fluctuated sharply, with the trend downward. On Sept. 22 the price here fell to 22.75c. for Straits tin, about ½c. higher than the low point reached last June. The market at the close was unsettled, with prices more or less nominal. The decline attracted a moderate amount of business.

Silver Firmly Held

The news of the change in British gold policy created wide interest in the silver market. Uncertainty over the future status of silver caused shorts to cover and prices advanced sharply. The offerings were light. Most of the buying was by China and India.

Other Metals

Quotations cover wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—**Per lb., delivered, Alcoa commercial and mill ingot, 99 and 98 per cent, 23.30c.; Alcoa No. 12 alloy, 22c.; metallurgical ingot, 94 per cent plus, 23.30c.; 98@99 per cent, 22.90c. London, £85, less 2 per cent, per long ton, for 98 per cent ingots and bars.**

ANTIMONY—**Per lb., duty paid,** Chinese, spot, 6.50c.; futures, 6.35c., nominal. Cookson's "C" grade, spot, 11½c. "CMC." grade, 99.9 per cent, spot, 11c.

BERYLLIUM—See Alloys.

BISMUTH—Per lb., in ton lots, reduced to $1.15 on Sept. 21. London, 4s. 9d.

CADMIUM—Per lb., 55c. London, 1s. 9d.@1s. 10d.

CHROMIUM—Per lb., 97@98 per cent grade, 85@90c. per lb. contained chromium. maximum 1 or 2 per cent iron. (Usually sold as ferrochrome.)

COBALT—Per lb.: Metal imported from Belgium, 97@99 per cent, $2.50 less 35 per cent for cash. On yearly requirements, usual rebate of 5 to 10 per cent, as to quantity. London quotes 7s., subject to usual discounts.

INDIUM—Per gram, minimum 99 per cent, $14@$15; 98½ per cent, $90@$100 per oz.

IRIDIUM—Per oz., $100@$105 for 98@99 per cent sponge and powder. London, £18@£19.

MAGNESIUM—Per lb., ingots (4x16 in.), 99½ per cent, 30c. in carloads; 32c. in 100 lb. lots or more, l.c.l.; ⅜, ½, 1, and 2 pound sticks, 5c. per pound over ingot price; ⅛ and ¼ pound sticks, 8c. per pound extra.

MANGANESE—Per lb., 95@97 per cent, 42c. (Usually sold as ferromanganese.)

MOLYBDENUM—Per lb., in 10- to 50-lb. lots, C.P. powder, $9; 97 per cent, $4.50. (Usually sold as calcium molybdate or ferromolybdenum, which see.)

NICKEL—Per lb. electrolytic cathodes, 35c.; shot and ingot made from remelted electro, 36c. for single lots of spot metal. London, per long ton, £170 @£175, as to quantity.

OSMIUM—Per oz., $60@$65. London, £13.

PALLADIUM—Per oz., $19@$21. London, £3 12s. 6d.@£4.

PLATINUM—Per oz. Official price of leading interest $40. Cash transactions between dealers and refiners at about $2 less. London official price £8; outside market £7 14s. Average price of Colombian crude for August, basis 85 per cent platinum, was $29.75.

QUICKSILVER — Per 76-lb. flask, $74@$76. Business was quiet with offerings fairly liberal. London quotes £15 8s. 9d., with prices unsettled.

RADIUM—Per mg. radium content, $50 in lots of 4 grams or more, to $65 for 1 gram; smaller quantities, $70.

RHODIUM—Per oz., $45@$50. London, £9@£9½.

RUTHENIUM — Per oz., $38@$42. London, £6½@£8½.

SELENIUM—Per lb., $1.80@$2, depending on quantity, for black, powdered, 99.5 per cent pure. London, 7s. 8d.@7s. 9d.

SILICON—Per lb., minimum 97 per cent Si, maximum 1 per cent Fe, 15@17c.

TANTALUM—Per kilo, $91 for C.P. bar or sheet.

TELLURIUM—Per lb., $2. London, 9s.@9s. 6d.

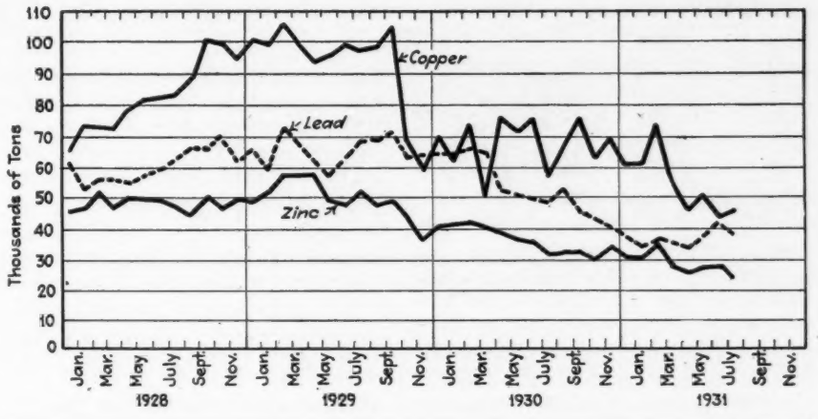
THALLIUM—Per lb., $12.50@$15.

TITANIUM—Per lb. in 50- to 100-lb. lots, 75 per cent, $5.

TUNGSTEN—Per lb. contained tungsten, 98 per cent, powdered, $1.45.

Domestic Shipments of Copper, Lead, and Zinc

The following graphic comparison of domestic shipments of copper, lead, and zinc, month by month, beginning with January, 1928, has been prepared by the American Bureau of Metal Statistics. Each of these metals goes mainly into construction, and to considerable extents they are used jointly. The identification of copper with the electrical industry is of course superior to that of either of the other metals and some divergences in the curves may be interpreted in that way.



Metallic Ores

Prices in tons of 2,000 lb., or in "units" of 20 lb., unless otherwise stated.

ANTIMONY ORE—No sales reported. London, per long ton unit, 3s.@3s. 6d. for 60 to 65 per cent sulphide ore.

BERYLLIUM ORE—Per unit of BeO, minimum 11 per cent BeO, $4@$5, f.o.b. mines. Per lb. BeO contained, 40c., c.i.f. European ports. Nominal.

CHROME ORE—Per long ton, c.i.f. Atlantic ports, Indian ores, $17.50 for 46@48 per cent Cr_2O_3 ore, and $19.50@$20 for 50@51 per cent ore. London, 74s. to 75s. for 48 per cent, with contract Rhodesian held at 80s. High-grade Indian and New Caledonian, 90s.@100s.

IRON ORE—Per long ton, Lower Lake ports. Lake Superior ores:

Mesabi, non-bessemer, 51½ per cent iron, $4.50. Old Range, non-bessemer, $4.65.

Mesabi, bessemer, 51½ per cent iron, $4.65. Old Range, bessemer, 51½ per cent, $4.80.

Eastern ores, cents per long ton unit, delivered at furnaces: Foundry and basic, 56 to 63 per cent, 10c.

Foreign ores, alongside docks Atlantic ports, cargo lots, cents per long ton unit:

North African and Swedish, low-phosphorus, 8½@9½c.

Spanish and North African, basic, 50@60 per cent, 8½@9c.

Swedish foundry or basic, 65@68 per cent, 9c.

Daily Prices of Metals

Sept.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
10	7.15	25.825	4.40	4.225	3.75@3.80
11	7.15	25.75	4.40	4.225	3.775
12	7.15	25.65	4.40	4.225	3.775
14	7.025	25.50	4.40	4.225	3.775
15	7.025	25.425	4.40	4.225	3.775
16	6.975	25.05	4.40	4.225	3.75
Av'ge	7.079	25.533	4.400	4.225	3.771
17	6.775	25.00@25.125	4.40	4.15@4.225	3.725
18	6.775	24.625@24.85	4.40	4.10@4.225	3.70@3.725
19	6.775	24.50@24.75	4.40	4.10@4.225	3.70@3.725
21	6.775	23.375@24.00	4.40	4.225	3.70
22	6.775	22.75@23.50	4.40	4.225	3.70
23	6.775	22.875@23.35	4.40	4.125@4.225	3.70
Av'ge	6.775	24.058	4.400	4.190	3.708

Average prices for calendar week ended September 12, 1931, are: Copper, 7.200c.; Straits tin, 25.725c.; New York lead, 4.400c.; St. Louis lead, 4.225c.; Zinc, 3.785c.; Silver, 27.900c.

Average prices for calendar week ended September 19, 1931, are: Copper, 6.892c.; Straits tin, 25.067c.; New York lead, 4.400c.; St. Louis lead, 4.198c.; Zinc, 3.742c.; Silver 27.729c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices of refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms of wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. The contract price for High-Grade zinc delivered in the East and Middle West is 1c. above the St. Louis price for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

Silver, Gold, and Sterling Exchange

Sept.	Sterling Exchange "Checks"	Silver		Gold, London	Sept.	Sterling Exchange "Checks"	Silver		Gold, London
		New York	London				New York	London	
10	4.85 1/2	27 7/8	12 15/16	84s 9 3/4d	17	4.85 7/16	27 5/8	12 7/8	84s 11 1/2d
11	4.85 3/8	28	13 1/16	84s 9 3/4d	18	4.85 1/4	27 1/2	12 3/4	84s 11 1/2d
12	4.85 1/2	28	13 1/16	.....	19	4.85	27 3/4	12 15/16	.....
14	4.85 1/2	27 7/8	13	84s 9 3/4d	21	4.00	29 1/4	14 3/8	84s 9 3/4d
15	4.85 1/2	27 3/4	13	84s 11 3/8d	22	4.10	28 5/8	15 3/8	99s 7d
16	4.85 7/16	27 7/8	13	84s 10 1/2d	23	4.10	29 1/2	16 1/4	100s

Average for week ended September 16: Silver, 27.896c.; Sterling Exchange, $4.85469.

Average for week ended September 23: Silver, 28.375c.; Sterling Exchange, $4.45948.

New York quotations are as reported by Handy & Herman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables, on Sept. 23, command a premium of 1/32c.

London

Sept.	Copper Standard		Electrolytic (Bid)	Tin		Lead		Zinc	
	Spot	3 M		Spot	3 M	Spot	3 M	Spot	3 M
10	30 3/4	31 1/2	34 1/2	115	117 1/2	10 13/16	11	10 13/16	11 5/16
11	30 1/16	30 7/8	34	115 1/4	117 3/4	10 13/16	11	10 7/8	11 5/16
14	29 1/2	30 3/8	33 1/2	114 1/2	117	10 11/16	10 13/16	10 3/4	11 1/4
15	29 1/4	30	33 3/4	113 3/4	116 1/4	10 5/8	10 15/16	10 15/16	11 7/16
16	28 1/2	29 3/8	33 1/2	110 3/4	113 1/4	10 9/16	10 3/4	10 11/16	11 3/16
17	28 3/16	28 15/16	32 1/2	111 1/2	114	10 7/16	10 7/16	10 5/16	10 13/16
18	27 11/16	28 7/16	32 1/2	111	113 1/2	10 11/16	10 3/4	10 3/8	10 7/8
21	32 1/4	33 1/2	36	118 3/4	121 1/4	12 5/8	12 3/4	11 3/4	12 1/4
22	30 1/2	31 1/4	36	117 5/8	120 1/2	12 3/4	12 13/16	12 1/4	12 3/8
23	32 3/8	33 1/4	37 1/2	119 7/8	122 3/4	13 1/4	13 1/4	12 5/8	13

Prices for lead and zinc are the official price for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

Newfoundland foundry, 55 per cent iron, 8½c. Nominal.

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, cargo lots, exclusive of duty: Brazilian, 46@48 per cent Mn, 23c.; Chilean, 47 per cent minimum, 29c.; Indian, 48@50 per cent, 25@26c.; Caucasian, 52@55 per cent, 26c.; South African, 52@54 per cent, 23@25c.; 50 to 52 per cent, 22@24c.; 44 to 46 per cent, 21½c. Prices almost entirely nominal as market is very dull.

Per ton in carload lots:

Chemical grades, powdered, coarse or fine, minimum 80 per cent MnO_2, Brazilian or Cuban, $50 in carloads, to $60 barreled. Javan or Caucasian, 85 per cent minimum, $50@$60. Domestic, 70 to 72 per cent, $40@$50 in carloads, f.o.b. mines.

MOLYBDENUM ORE—Per lb. of contained MoS_2, nominally 45c., delivered Pittsburgh, for 75@85 per cent concentrate. London, per long ton unit, nominal at 28s. 6d. to 30s. for 80@85 per cent concentrate.

TANTALUM ORE—Per lb. Ta_2O_5, 70c. for 60 per cent ore. Market nominal.

TIN ORE — No market in United States. London, returning charge on 60 per cent Bolivian, £8 15s.@£9 per long ton; on 70 per cent Nigerian, £6 17s. 6d., basis £200.

TITANIUM ORE — Per gross ton, ilmenite, 45@52 per cent TiO_2, f.o.b. Atlantic seaboard, $10@$12, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7@$8. Rutile, per lb., guaranteed minimum 94 per cent concentrate, 10c.

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Chinese wolframite, $11.25, duty paid. Bolivian scheelite, $11.50. Domestic, $12. Shipments of odd carlots do not command full prices. Market is very dull, but there is some inquiry for 1932 shipment.

VANADIUM ORE—Per lb. V_2O_5 contained, 27c., f.o.b. shipping point. London, 16 to 18 per cent V_2O_5, nominal at 45s.@47s. 6d. per long ton unit, c.i.f., on contract.

ZIRCON ORE — Per ton, 55 per cent ZrO_2, f.o.b. Atlantic seaboard, $40@$45 in 30-ton lots. Crude granular zircon, $70, f.o.b. Suspension Bridge, N. Y.; milled, $90.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.

Tons of 2,000 lb. unless otherwise noted.

AMBLYGONITE — Per ton, f.o.b. mines, 8@9 per cent Li_2O, $50@$60.

ASBESTOS — Per ton, f.o.b. Quebec

mines, tax and bags included: Crude No. 1, $250@$350; crude No. 2, $200@$250; spinning fibers, $90@$175; magnesia and compressed sheet fibers, $100@$125; various grades shingle stock, $45@$65; various grades paper stock, $27.50@$35; cement stock, $15@$20; floats, $10@$12.

Per ton c.i.f. New York: Rhodesian crude No. 1, $300; No. 2, $200. Nominal.

Per ton, c.i.f. New York: Russian crude No. 1, $220@$250; No. 2, $175@$200; No. 3, $125@$150. Nominal.

Per ton, f.o.b. mines, Vermont: Shingle stock, $55; paper stock, $35; cement stock, $20.

BARIUM CARBONATE (Witherite) — Per ton, 90 per cent 300 mesh, $42; 100 mesh, $39.

BARYTES—F.o.b. mines, bags extra:

Georgia: Barytes ore, crude, $6@$6.50 per long ton.

Missouri: Per ton, water ground and floated, bleached, $23, car lots, f.o.b. works. Crude ore, minimum 95 per cent $BaSO_4$, less than 1 per cent iron, $6; 1 per cent iron and 93 per cent $BaSO_4$, $5.50, f.o.b. mines.

BAUXITE—Per long ton: Domestic ore, chemical, crushed and dried, 55 to 58 per cent Al_2O_3, 1.5 to 2.5 per cent Fe_2O_3, $6.50@$8, f.o.b. *Alabama* and *Arkansas* mines. Other grades, 56 to 59 per cent Al_2O_3, 5 to 8 per cent SiO_2, $6@$7.50, f.o.b. *Arkansas* mines. Pulverized and dried, 56 to 59 per cent Al_2O_3, 8 to 12 per cent SiO_2, $10@$12.25, f.o.b. *Arkansas* mines; abrasive grade, crushed and calcined, 78 to 84 per cent Al_2O_3, $14@$16, f.o.b. *Arkansas* mines.

Per metric ton, foreign, c.i.f. Atlantic ports: Dalmatian, 50 to 55 per cent Al_2O_3, 1 to 3 per cent SiO_2, $4.50@$6.50. Istrian, 54 to 57 per cent Al_2O_3, 3 to 5 per cent SiO_2, $5.50@$7; French, 56 to 59 per cent Al_2O_3, 2 to 4 per cent SiO_2, $6@$8.

BENTONITE—Per ton, carload lots, f.o.b. *Wyoming* mines, dried and crushed, in bulk, $8; in bags, $10. F.o.b. Chicago, selected air-floated, $25.

BORAX — Per ton, carload lots, in bags, crystals, $56; granulated, $50; powdered, $57.50; f.o.b. shipping point.

CELESTITE—Per ton in carload lots, 90 per cent $SrSO_4$, finely powdered, $27.

CHINA CLAY (KAOLIN)—Per ton, f.o.b. *South Carolina* mines, crude lump, No. 1, $5: crushed air-floated, $7; pulverized, $9@$10.

Florida, washed and crushed, No. 1, $12.50; No. 2, $12.

Delaware, No. 1, $14.50.

Imported English, f.o.b. American ports: lump, $17@$21 in bulk.

DIATOMITE—Per ton, f.o.b. *Nevada*, crude, dried, in bags, $10; minus 40 mesh, $15; 300 mesh, $20; high temperature insulation, $30. Market fair, with biggest sale of insulation grade for homes, hotels, and hospitals.

EMERY—Per ton, f.o.b. *New York*, domestic crude ore, first grade, $10. Other American ore, delivered to grinders, per gross ton, $15; Turkish and Naxos ore, $30@$35. F.o.b. *Pennsylvania*, in 350-lb. kegs, Turkish, Khasia, and Naxos grain emery, 6½c. per lb.; American, 3½c.

FELDSPAR — Per ton, f.o.b. *North Carolina*, potash feldspar, 200 mesh, white, $15, in bulk; soda feldspar, $18. F.o.b. *Maine*, potash feldspar, white, 200 mesh, $19, in bulk. Granular glasspar, f.o.b. *North Carolina*, $10.50 in bulk.

Virginia, No. 1, 325 mesh, $17; 200 mesh, $15@$16; 160 mesh, $14@$15; No. 1 glassmakers', $11; enamelers', $12.50.

New Mexico: Crude clean No. 1 potash spar, $4.75; ground, $9.50.

FLUORSPAR — Per ton, f.o.b. *Kentucky* and *Illinois* mines:

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, $13. Foundry lump, 85-5, $15. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $30 in bulk; $34 in bags or barrels. *Colorado* mines, 82-5, $12.75.

Foreign fluorspar, gravel, 85-5, $18.50 per gross ton, duty paid.

FULLER'S EARTH — Per ton, f.o.b. *Colorado*, $18, various finenesses to minus 90 mesh.

F.o.b. *Georgia* or *Florida*, 30 to 60 mesh, $17; 15 to 30, $16; 200 up, $10; 100 up, $7.

GARNET—Per ton, f.o.b. *New Hampshire* mines: concentrate, $40; washed grades, $125.

New York: Adirondack garnet concentrates, $85.

Spanish grades, $60, c.i.f. port of entry.

GILSONITE — Per ton, carload lots, f.o.b. *Colorado:*

Brilliant black, $32.90; seconds (mine run), $25.50.

Selects, $30.50, f.o.b. Utah. Nominal.

GRAPHITE—Per lb., f.o.b. *New York:* Ceylon lump, 6½@7½c.; carbon lump, 3@6c.; chip, 5@6c.; dust, 3@4c.; Madagascar flake, 5@6c.

No. 1 flake, 8@16c.; No. 2, 5c. upward; fine ground, 3c. upward; amorphous, 3c. upward.

Crude amorphous graphite, $15@$35 per ton, according to grade.

GREENSAND — Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade, in carload lots, $20.

GYPSUM—Per ton, f.o.b. mill, crushed rock, *Iowa*, $2.50; *Ohio* and *New York*, $3. Ground, *Ohio*, $4; *Iowa*, $6. Agricultural, $6@$7. Calcined, $6@$9.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 3@4½c.; domestic earth, 2@4½c.

KAOLIN—See China Clay.

KIESELGUHR—See Diatomite.

LEPIDOLITE—Per ton, $50@$60 for ordinary grades. Nominal.

LIMESTONE—Per ton, f.o.b. shipping points, depending on location, either lump or crushed, 25c.@$1.75.

Agricultural, $1 up to $6 per ton, as to grade and point of shipment.

MAGNESITE—Per ton, f.o.b. *California*, dead-burned, $25. Kiln run, 93 per cent MgO (artificial periclase), $68; 88 per cent MgO, $35. Caustic, 95 per cent MgO, $45; 90 per cent, $40. *Washington:* Dead-burned grain magnesite, $22.

MICA—Per ton, f.o.b. *New Mexico*, scrap, white, $21; off color, $18. Punch, white, for disks, per lb., 10c.; for washers, 8c.

Per ton, f.o.b. *New Hampshire*, roofing mica, $23; snow, $34; 40 mesh white, $40; 60 mesh, $48; 100 mesh, $60; 200 mesh, $75. Clean dry mixed bench and mine scrap, $13.

Per lb., f.o.b. *North Carolina*: Punch, 3@5c.; 1½x2 in., 20@30c.; 2x2, 30@50c.; 2x3, 60@90c.; 3x3, $1@$1.40; 3x4, $1.40@$1.80; 3x5, $1.50@$2; 4x6, $2.25@$3; 6x8, $2.50@$3.75; 8x10, $5@$7.50. These prices apply both to No. 1 and No. 2 mica. Black-stained mica takes a discount of 10 to 25 per cent from this schedule. White North Carolina mica, 70 mesh, $60 to $80. Biotite, or black mica, $15 a ton, unground.

MINERAL BLACK—(Graphitic shale) —Per ton, 325 mesh, 75 per cent carbon. $22.50, f.o.b. *Virginia*.

MONAZITE—Per ton, minimum 6 per cent ThO_2, $60.

OCHER — Per ton, f.o.b. *Georgia* mines, $17.50 in sacks; $20 in barrels. Buff clay, 98 per cent through 325 mesh, $18.

F.o.b. *Virginia*, dark yellow, 300 mesh, 60 per cent ferric oxide, in jute bags, $19.50.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7.15; 75 per cent, $6.40; 74@75 per cent, $6.15; 70 per cent, $4.65; 68 per cent, $4.10.

Florida, pebble, domestic: 76@77 per cent, $6.50; 74@75 per cent, $5.50; 72 per cent, $4.50; 70 per cent, $4.

Tennessee, ground lime phosphate, 80 per cent through 300 mesh, 33 per cent P_2O_5, $12.80 per net ton, bags extra.

PUMICE STONE—Per lb., in barrels, powdered, 2½@4c.; selected lump, 5@7c.

PYRITES—Per long ton unit of sulphur, c.i.f. United States ports, guaranteed 48 per cent sulphur, Spanish, 13c.

POTASH—Per ton, contracts:

	Bags	Bulk
Muriate of potash, 80@85 per cent, basis 80 per cent	$37.15	$35.55
Sulphate of potash, 90@95 per cent, basis 90 per cent	48.25	46.65
Sulphate of potash-magnesia, 48@53 per cent, basis 48 per cent	27.80	26.20
Manure salt, 30 per cent	22.15	19.15
Manure salt, 20 per cent	15.65	12.65
Kainit, 14 per cent	12.70	9.70

Prices are delivered to Atlantic ports. Discounts up to 4 per cent for early shipment. Spot prices, $1.25@$1.50 per ton higher than on contract.

[1]QUARTZ ROCK CRYSTALS—For fusing, all sizes, $250 per ton. Prisms for piezo-electrical use, $3 per lb. in small lots. Optical grades command premium.

SILICA—Per ton, water ground and floated, in bags, f.o.b. *Illinois:* 325 mesh, $16@$40 for 92 to 99½ per cent grades. Dry ground, air-floated, 325 mesh, 92@99½ per cent silica, $14@$30. Market steady. Glass sand, f.o.b. producing plant, $1.25@$5 per ton; molding sand, 50c.@$3.50; blast sand, $1.75@$6.

[1]STRONTIANITE — Per ton, lump in carload lots, minimum 90@92 per cent $SrCO_3$, $100.

SULPHUR—Per long ton for domestic market, $18 f.o.b. Texas mines; $22 for export, Atlantic ports.

TALC — Per ton, carload lots, f.o.b. works, containers included unless otherwise specified:

New Jersey: Soapstone, ground, $10@$12.

New York: Double air-floated, short fiber, 200 mesh, $13.75; 325 mesh, $14.75.

Vermont: 99 per cent through 200 mesh, extra white, bulk basis, $8@$8.50; 97 to 98 per cent through 200 mesh, medium white, $7@$7.50. Packing in paper bags, $1 per ton extra.

Virginia: 200 mesh, $4.60@$8.25; 325 mesh, $8.75@$10.50.

TRIPOLI — Per ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh, rose and cream colored, $15. Double ground through 110 mesh, rose and cream, $17. Air-floated through 200 mesh, rose and cream, $22.50.

Metalic Compounds

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c., delivered, all positions. London, per long ton, £20@£20 10s. for Cornish white. Mexican, high grade, £17@£17 5s.

CALCIUM MOLYBDATE OR MOLYTE—Per lb. of contained Mo, 85c.

COBALT OXIDE—Per lb., black oxide, 70@71 per cent grade, $1.35.

COPPER SULPHATE (Blue Vitriol)—Per lb., in car lots, 3.40c. for either large or small crystals.

GERMANIUM DIOXIDE—Per gram, in 200- to 300-gram lots, $3.50.

SODIUM NITRATE—Per 100 lb., crude natural, in bags ex vessel, Atlantic ports, $2.05.

SODIUM SULPHATE (Salt Cake)—Per ton, bulk, f.o.b. works, $16@$18.

ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6¼c.; French red seal, in bags, 9⅜c.

ZIRCONIUM DIOXIDE—Per lb. in 100- to 500-lb. lots, 87 per cent ZrO_2, commercial, 50c.

Refractories

CHROME BRICK—Per ton, f.o.b. shipping point, $45. Grecian refractory ore, 37@42 per cent, 40c. per unit.

FIRECLAY BRICK — Per M., first quality, $40, *Ohio, Kentucky, Central Pennsylvania;* second quality, $35.

MAGNESITE — Brick, per ton, f.o.b. works, 9-in. straights, $65. Dead-burned grain, $40, f.o.b. Chester, Pa., or Baltimore.

SILICA BRICK—Per M., *Pennsylvania,* $40: *Alabama,* $50@$51; *Illinois* and *Indiana,* $49.

ZIRKITE—Per lb., powdered, 65@70 per cent ZrO_2, 3½c. Brick, straights, 80c.@$1 each.

Alloys

BERYLLIUM—Per lb. of contained Be, $50, chiefly sold as an alloy of 12 per cent Be and 88 per cent Cu.

FERROCHROME — Per lb. of contained chromium, 4 to 6 per cent carbon, 65 to 70 per cent chromium, 11c., delivered on contracts; spot, 11½c. Containing 2 per cent carbon, 67 to 72 per cent chromium, spot, 17½c.; maximum 0.10 per cent carbon, 26c., spot; 24½c. contracts.

FERROMANGANESE — Per gross ton furnace: domestic and foreign, 78@82 per cent, $80@$85, contracts, depending on quantity. Spiegeleisen, 19@21 per cent, $30 for spot carloads.

FERROMOLYBDENUM—Per lb. of Mo. f.o.b. shipping point, 50@60 per cent Mo, $1.

FERROPHOSPHORUS—Per gross ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50, f.o.b. *Alabama* and *Tennessee.*

FERROSILICON — Per gross ton, delivered, 50 per cent, $83.50; 75 per cent, $130; 14@16 per cent, $31, f.o.b. Niagara Falls, N. Y. Spot shipments $5@$10 per ton higher on 50 and 75 per cent grades.

FERROCARBONTITANIUM — Per ton, $150, f.o.b. producer's plant, carlots.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1@$1.10, f.o.b. works.

FERROVANADIUM—Per lb. of V contained, delivered, $3.15@$3.50.

SILICOMANGANESE — Per long ton, carload contracts, delivered, $105 for maximum 2½ per cent carbon; $115 for maximum 1 per cent carbon.

SILICON ZIRCONIUM—Per lb., 47@52 per cent Si, 35@40 per cent Zr, 18@21c.

ZIRCONIUM FERROSILICON—Per gross ton, 12@15 per cent Zr, 39@43 per cent Si, $103.50@$108.50.

Rolled Metals

COPPER — Per lb., sheets, hot-rolled, 17⅛c.; wire, f.o.b. mill, 9c.

LEAD SHEETS — Per lb., full rolled, 7¼c.; clipped, 7½c.

MONEL METAL—Per lb., sheets, full finished, 42c.; strip, cold-rolled, 45c.; rods, hot-rolled, 35c.

MUNTZ METAL—Per lb., rods, 14¼c.; plates, 17⅛c.

NICKEL—Per lb., sheets, full finished, 52c.; rods, hot-rolled, 45c.

NICKEL SILVER — Per lb., sheets, 10 per cent, 22⅜@22¾c.; 18 per cent, 25⅞@26¼c. Wire and rods, 10 per cent, 25⅞c.; 15 per cent, 29⅞c.; 18 per cent, 33⅜c.

PHOSPHOR BRONZE—Per lb., sheets and rods, 5 per cent tin, 28⅜c.; wire, 5 per cent, 28⅞c.; 10 per cent, 33⅜c.

ZINC SHEETS—Per lb., 9c., f.o.b. works; ribbon 8½c.; 7 per cent discount on orders for 18 tons or more.

Iron, Steel, and Coke

IRON—Per gross ton, Valley furnaces: Bessemer, $17; basic, $17; and No. 2 foundry, $17.

STEEL—Per gross ton, base prices Pittsburgh, billets and slabs, $29; bars, plates, and structural shapes, per 100 lb., $1.60.

COKE—Per ton, Connellsville furnace, $2.40@$2.50. Connellsville foundry, $3.25@$4.50. Birmingham furnace, $3.50@$4.50. Byproduct coke, Ohio and Kentucky (Connellsville basis), $5.50; Buffalo and Detroit, $8@$8.50; Birmingham foundry, $5.

[1]Price furnished by Foote Mineral Company, Philadelphia.